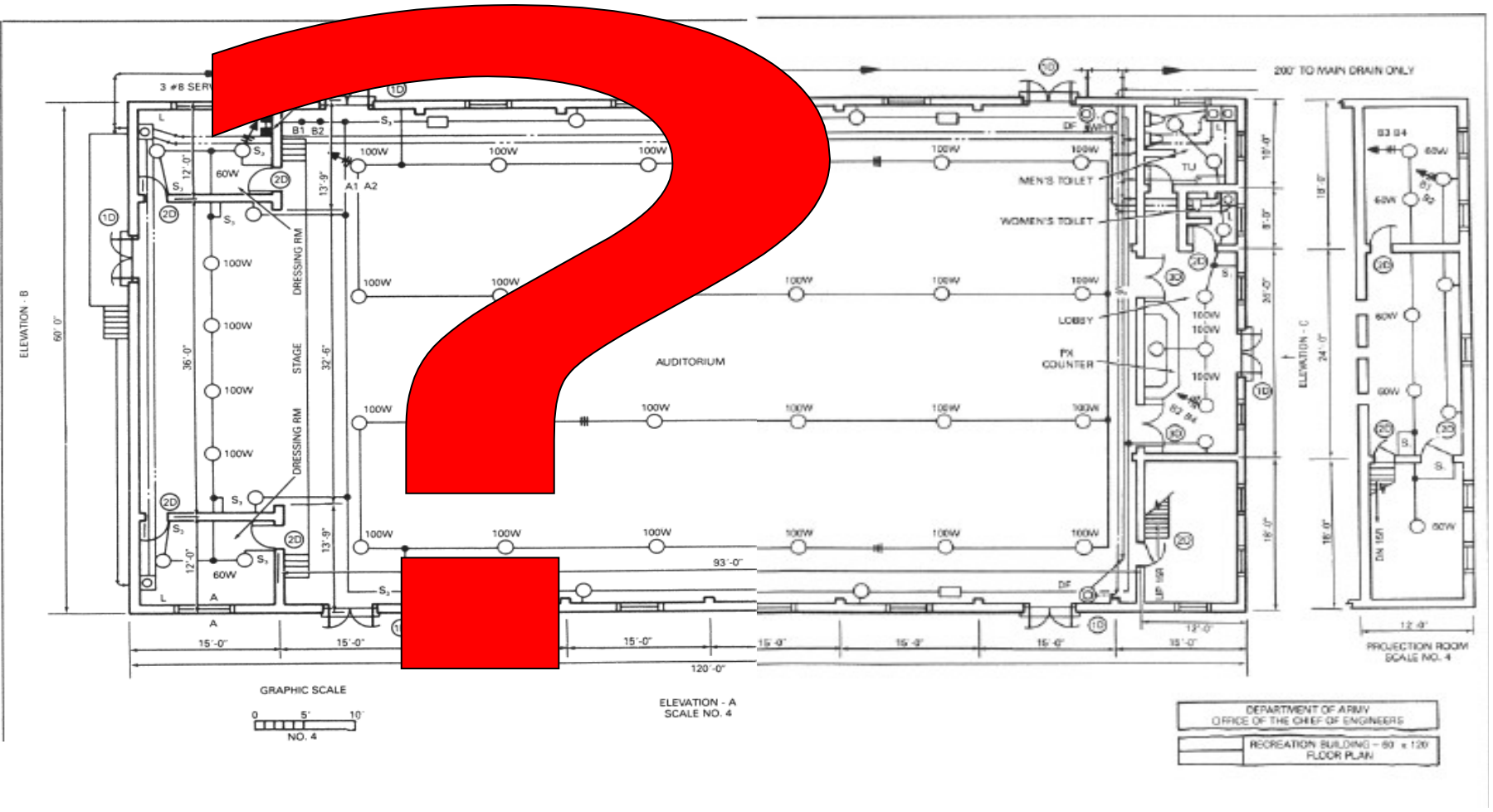
Vertical Construction

Vertical Construction



Vertical Construction

Vertical Construction

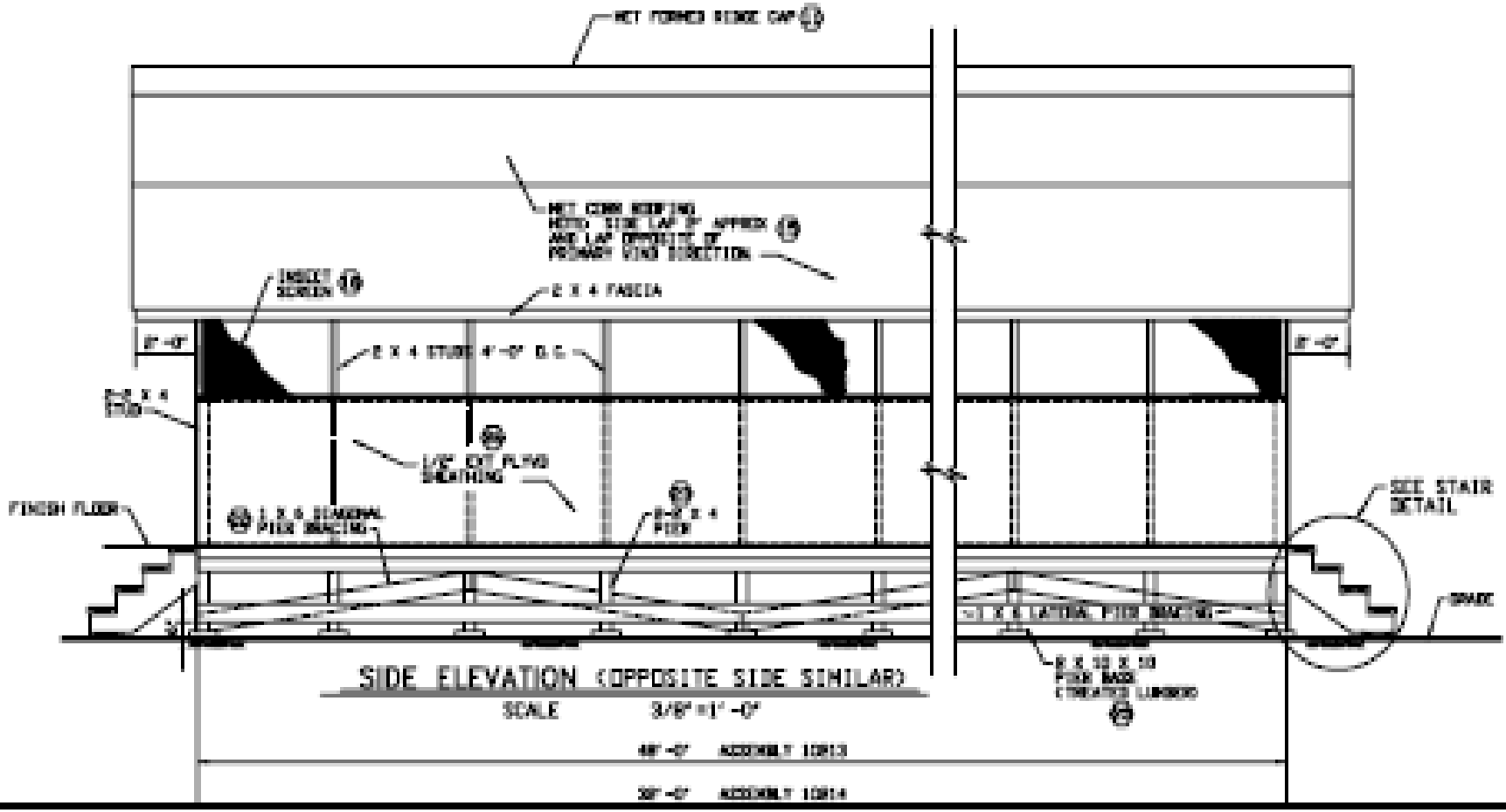
Topics to discuss

- Wood Frame Construction
- Lumber
- Fasteners
- Joints and Splices
- Bill of Materials
- Foundations
- Floor Frames and Coverings
- Stairs
- Wall Framing
- Roof Framing

Vertical Construction

Vertical Construction

Wood frame Construction



Vertical Construction

Wood frame Construction

- FRAMING IS THE ROUGH TIMBERWORK OF A BUILDING.

Vertical Construction

Wood frame Construction

- Light Wood Framing
- Heavy Wood Framing
- Expedient Wood Framing

Major difference between light, heavy, and expedient wood framing is the: size and composition of the building material as well as the fasteners used to connect the components.

Vertical Construction

Light Wood Framing

- Barracks
- Administration Buildings
- Light Shop Buildings
- Hospitals

Vertical Construction

Light Wood Framing

- Common Lumber
  - (1) 2” x 4”
  - (2) 1” x 4” (etc.)
- Plywood

Vertical Construction

Heavy Wood Framing

- 6” Dimension
- Bunkers and Non-standard Bridges

Vertical Construction

Expedient Wood Framing

- Light Siding
- Salvaged Framing
- Local Timber
- Wood Substitute Framing
- Excavations

Vertical Construction

Vertical Construction

Lumber

SIZE: Sawed to standard size: length, width, and thickness; an untreated 2” x 4” is actually (1 1/2” x 3 1/2”)

GRADE: No. 1 common to No. 5

- Note: Treated may vary due to swelling or shrinkage during pressure treating process
- ** NOTE: No. 2 common is the most commonly

Vertical Construction

Lumber

Vertical Construction

Lumber: Plywood

SIZE: Standard size in length, width is 4ft x 8ft and thickness varies

GRADE: AA to CD

* NOTE: CD is commonly used for exterior sheath

Vertical Construction

Lumber: Plywood

Vertical Construction

Vertical Construction

Fasteners

- Common nails
- Finishing nails
- SCAFFOLD, or FORM NAILS
- ROOFING NAILS
- CUT NAILS

Vertical Construction

Fasteners

Vertical Construction

Fasteners

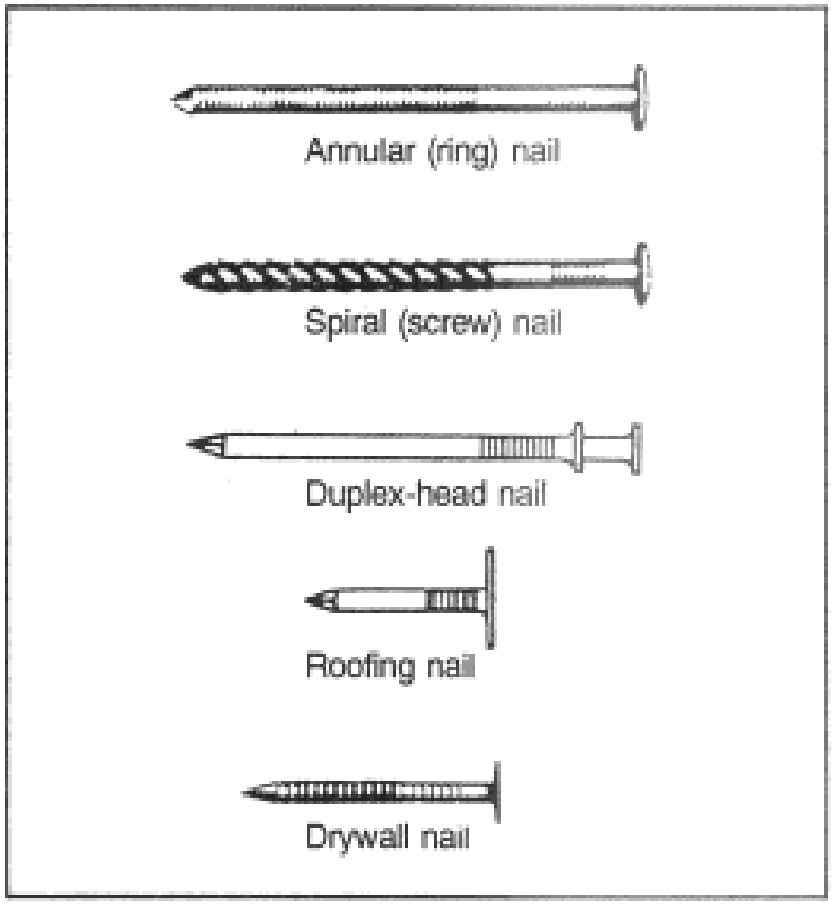


Figure 2-6. Specialized nails

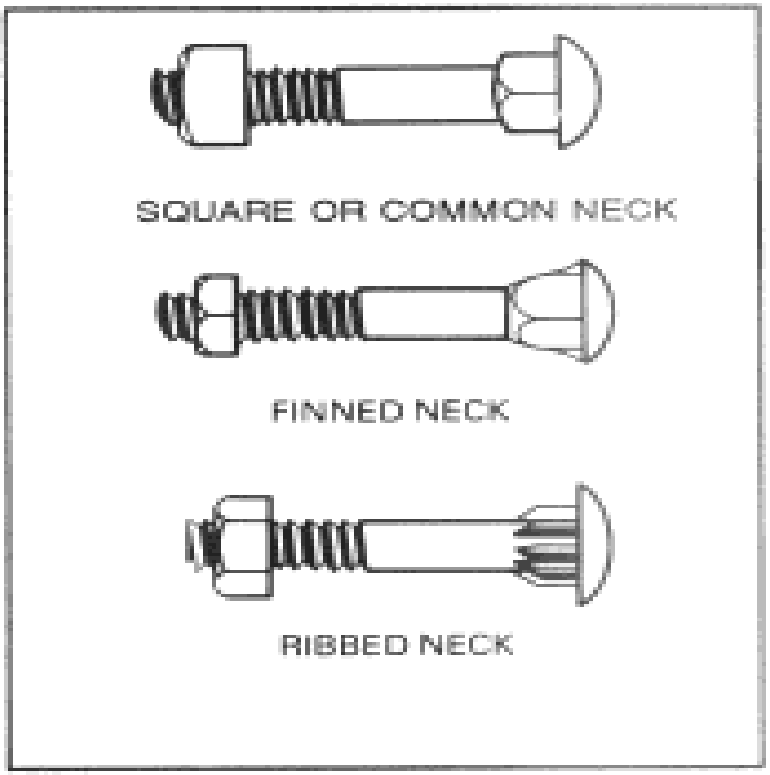
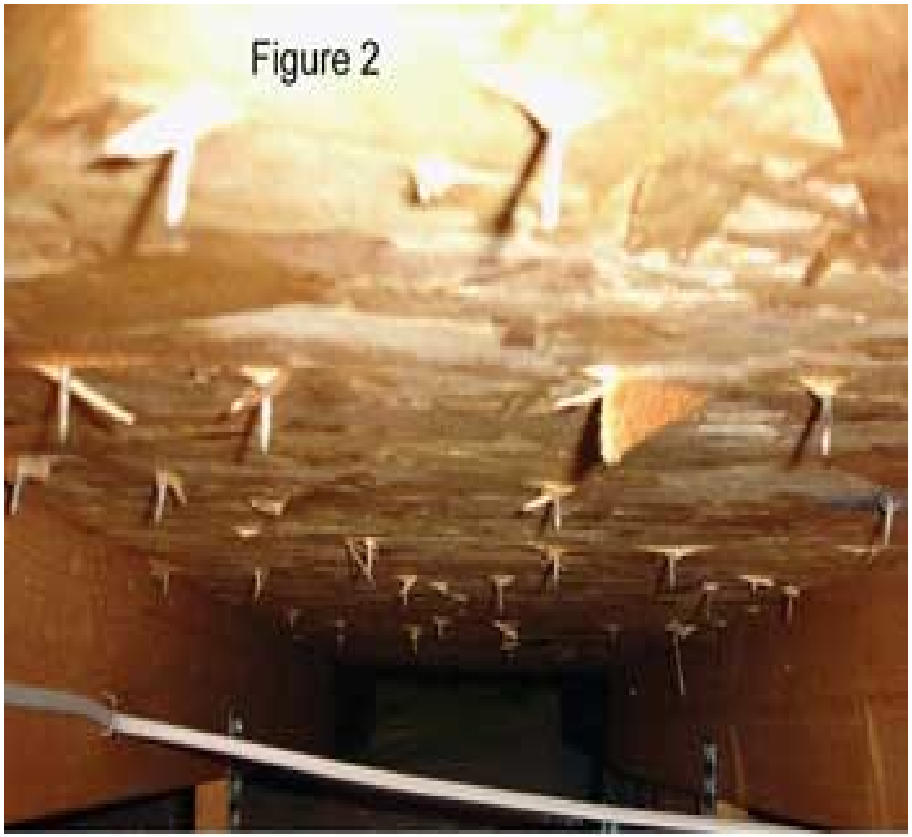


Figure 2-11. Carriage bolts

Vertical Construction

Fasteners



Vertical Construction

Fasteners

Table 2-5. Lag-screw sizes

LENGTHS (INCHES)	DIAMETERS (INCHES)			
	1/4	3/8, 7/16, 1/2	5/8, 3/4	7/8, 1
1	X	X		
1 1/2	X	X	X	
2, 2 1/2, 3, 3 1/2, so forth, 7 1/2, 8 to 10	X	X	X	X
11 to 12		X	X	X
13 to 16			X	X

Vertical Construction

Fasteners

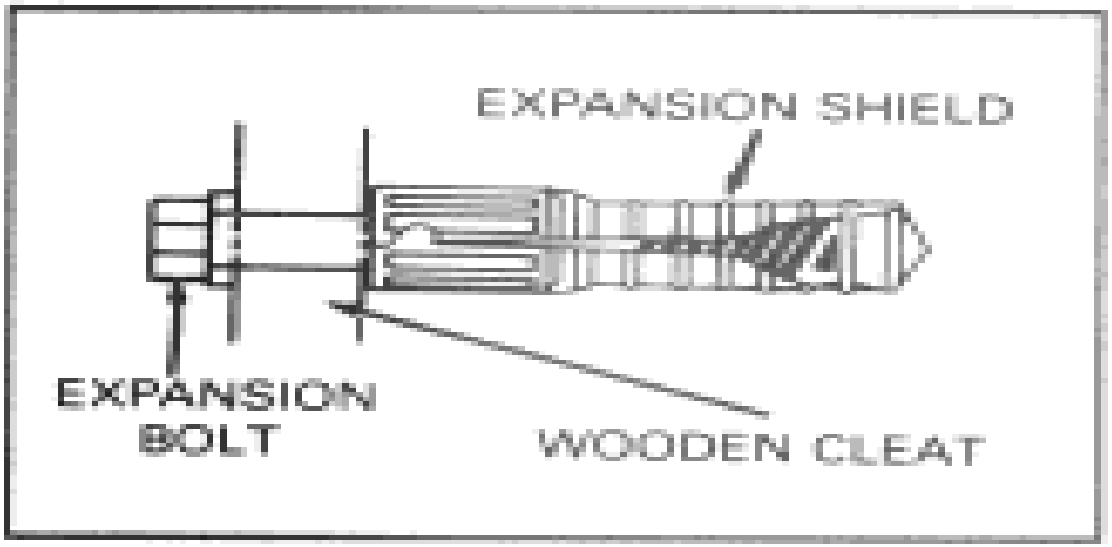
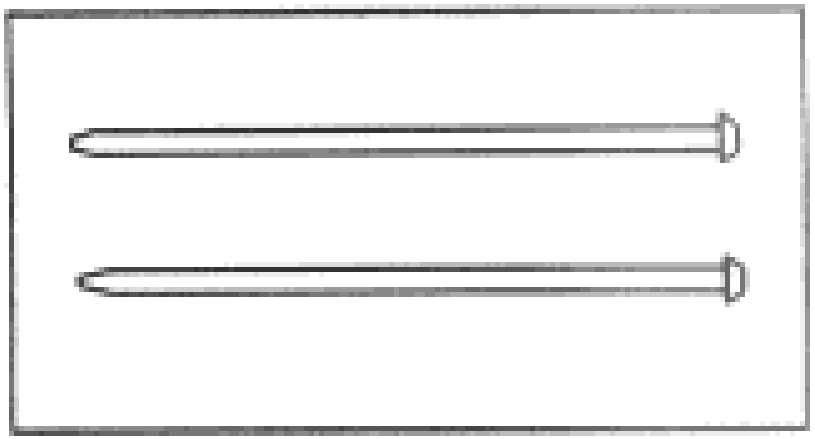


Figure 2-14. Expansion bolt and shield

Vertical Construction

Fasteners: Timber connectors



- DRIFTPINS: to hold HEAVY pieces of timber/lumber together
- Corrugated fasteners

Vertical Construction

Fasteners: Timber connectors

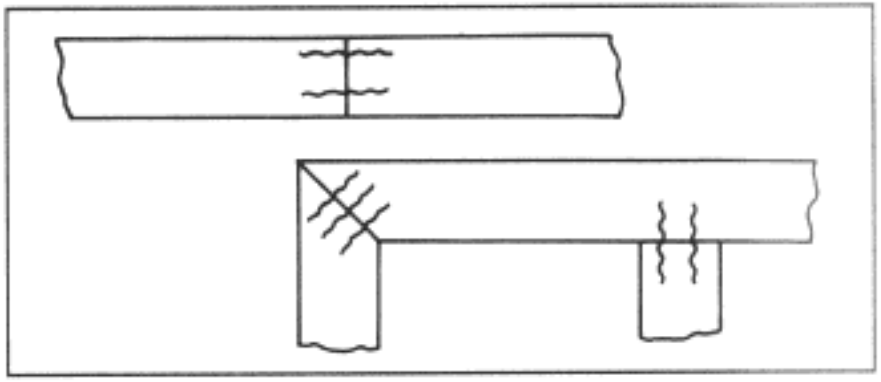


Figure 2-17. Proper use of corrugated fasteners

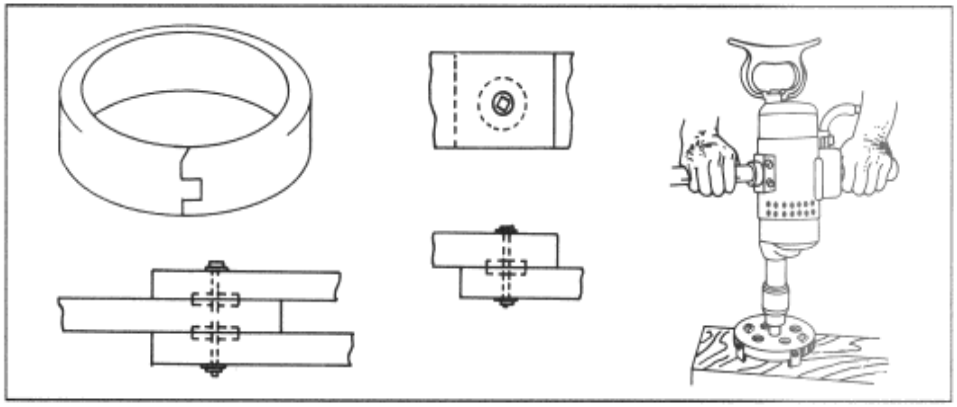


Figure 2-18. Split-ring installation

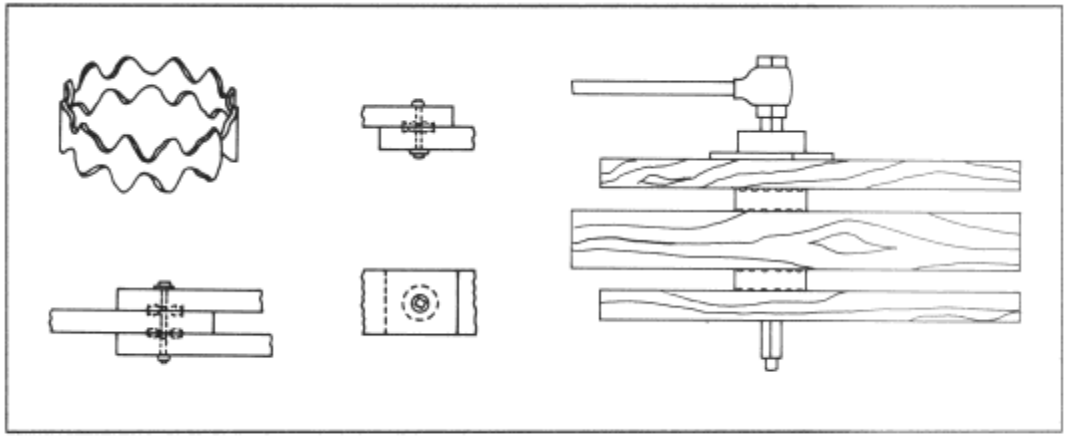


Figure 2-19. Toothed-ring installation

Vertical Construction

Vertical Construction

Joints and Splices

Vertical Construction

Joints

Connection between two pieces of timber which come together at various angles.

There are two basic types of joints:

- Butt Joints
- Lap Joints.

Vertical Construction

Splices

- Splices connect two or more pieces of material that extend in the same line.
- The joint will be as strong as the unjointed portions.
- The type of splice used depends on the type of stress and strain that the spliced timber must withstand.

Vertical Construction

Splices

· *Vertical supports* (longitudinal stress) require splices that resist compression.

· *Trusses, braces, and joists* (transverse and angular stress) require splices that resist tension.

· *Horizontal supports,* such as girders or beams, require splices that resist bending tension and compression.

Vertical Construction

Building Estimations

Vertical Construction

Bills of Materials

- Used to order all materials to construct a project

ITEM	NSN	NOMENCL	QTY/BF	UNIT	TOTAL PRICE
1	5511001C000604	2x4x10’0"	134/893.33	0.34	$303.73
2	552001C000599	2x4x8’0"	184/981.33	0.33	$323.25
3	551001C000626	2x8x12’0"	96/1536.00	0.42	$645.00

Vertical Construction

Material Take Off Sheet

- Used to list all materials needed to build the structure
- Calculate to the hundredths place 0.0<u>0</u> without rounding up (or down)

Vertical Construction

Material Take Off Sheet

Table 3-1. Materials takeoff list for a 20- x 40-foot building

ITEM NAME OR USE OF PIECE	NO. OF PIECES	UNIT	LENGTH IN PLACE	SIZE	LENGTH	NO. PER LENGTH	QUANTITY
1. Footers	45	PC	1'- 5"	2x6	10'	7	7
2. Spreaders	30	PC	1'- 4"	2x6	8'	6	5
3. Foundation Post	15	PC	3'- 0"	6x6	12'	4	4
4. Scabs	20	PC	1'- 0"	1x6	8'	8	3
5. Girders	36	PC	10'- 0"	2x6	10'	1	36
6. Joists	46	PC	10'- 0"	2x6	10	1	46
7. Joist Splices	21	PC	2'- 0"	1x6	8'	4	6
8. Block Bridging	40	PC	1' - 10⅜"	2x6	8'	4	10
9. Closers	12	PC	10'- 0"	1x8	10'	1	12
10. Flooring	800	BF	RL	1x6	RL	—	—

Vertical Construction

Material Take Off Sheet

Estimating quantity of nails required

- For flooring, sheathing, and other 1-inch material, use the following formula:

Number of pounds (2 penny through 8 penny) =

$$\frac{penny}{4} \times \frac{board\ measure}{100}$$

- For framing materials that are 2 inches or more, use the following formula:

Number of pounds (10 penny through 60 penny) =

$$\frac{penny}{6} \times \frac{board\ measure}{100}$$

Vertical Construction

Materials Estimate List

Table 3-2. Materials estimate list

ITEM	SIZE & LENGTH	UNIT	TAKEOFF QUANTITY	WASTE ALLOWANCE	ADDITIONAL REQUIREMENTS	TOTAL QUANTITY	BD FT MEASURE
1.	6 x 6 x 12	PC	4	1	None	5	180
2.	2 x 6 x 10	PC	89	9	None	98	980
3.	2 x 6 x 8	PC	15	2	3 For Temporary Bracing	20	160
4.	1 x 8 x 10	PC	12	2	None	14	91
5.	1 x 6 x 8	PC	9	2	2 For Batter Boards	13	52
6.	1 x 6 x RL	BF	800	160	None	960	960
7.	16d	LB	—	—	36 Nails, Framing	36	—
8.	8d	LB	—	—	23 Nails, Flooring	23	—

Vertical Construction

Lumber Consolidation Sheet

- Used to consolidate lumber items of the same size from the material take off sheet

ITEM	QTY	UNIT SIZE	LENGTH	BF	REMARKS

Vertical Construction

Basic math review

a. Converting from feet to inches by multiplying by 12

Converting from inches to feet by dividing by 12

b. Converting from fractions to decimals by dividing the numerator (top) by the denominator (bottom) or use Table

Vertical Construction

Basic math review

c. Subtraction

12’ 4 3/8” minus 1’ 7” = 10’ 9 3/8

d. Pythagorean Theorem – used to find the 3rd side of a triangle

$$A^2 + B^2 = C^2$$

Vertical Construction

Economical Order length

- Provides the most pieces needed, leaving the least amount of waste.
- Lumber common lengths are:

  8, 10, 12, 14, 16

- There are three (3) EOL rules

*NOTE: 18’ & 20’ is considered a special order and WILL NOT be used for practical applications or

Vertical Construction

Economical Order length Rule # 1

- Process of elimination / Pre-determined
- When the EOL is approximately the same length as the building component

Vertical Construction

Economical Order length Rule # 1

- If a Component is 13’
- 8’ 10’ 12’ are too short and 14’ will cover the span with less waste than 16’

EOL = 14’

Vertical Construction

Economical Order length Rule # 2

Total linear feet

When EOL needs to cover the total linear footage

FORMULA:

TLF ÷ EOL = # OF EOL PIECES

Vertical Construction

Economical Order length Rule # 2:

Understanding Economical Order Length Rule #2:		
Available Lengths of lumber:	Bldg Length:	# of pieces to meet the requirement:
16	32	2
14	32	2.285714286
12	32	2.666666667
10	32	3.2
8	32	4

- Select the whole number or the number with greatest value after decimal point.
- In the example above, a 12’ piece has the greater value after the decimal BUT the 8’ piece has zero waste since it evenly goes into the length, 32’, 4 times.
- Choose 8’ as your most economical order

Vertical Construction

Economical Order length Rule # 3: More Than One Piece From EOL

EOL is long enough to acquire more than one building component

FORMULA: Divide EOL by length Of Piece

*NOTE: CHANGE TO INCHES

Vertical Construction

Economical Order length Rule # 3:
More Than One Piece From EOL

Understanding Economical Order length Rule #3:						
step #1: Convert all measurements to inches						
	this allows for greater accuracy					
Length of component:			EOL			
in feet	in inches		in feet	in inches		
3' 9"	45		16	192		
			14	168		
			12	144		
			10	120		
			8	96		
Step #2: Divided all EOL by the length of piece (in inches)						
EOL (in inches)	Length of component (in inches):					EOL/LoC
192	45					4.266666667
168	45					3.733333333
144	45					3.2
120	45					2.666666667
96	45					2.133333333

Step 3: Determine which has the LEAST amount of waste. (pick the WHOLE number w/out waste OR the smallest number after the decimal point. This gives you the yield, in number of pieces, of one board.)

Vertical Construction

Vertical Construction

Foundations

- Foundations vary according to their use, the soil-bearing capacity, and the type of material available.

- Depending on the weight the foundation is to Support, the material may be cut stone, rock, brick, concrete, tile, or wood.

- Foundations may be classified as wall or column (pier) foundations.

Vertical Construction

Foundation: Wall Foundations

- Wall foundations are solid their total length and are usually used when heavy loads are to be carried or where the earth has low supporting strength.

- These walls may be made of concrete, rock, brick, or cut stone, with a footing at the bottom.

- This type of wall will be used in the TO only when other types cannot be used, because of the time, labor, and material required to build.

- Steel-rod reinforcements should be used in all concrete walls

Vertical Construction

Foundation: Wall Foundations

Rubble stone masonry is used for walls both above and below ground and for bridge abutments. In military construction, it is used when form lumber for masonry units is not available.

Rubble masonry may be laid up with or without mortar; if strength and stability are desired, mortar must be used.

Vertical Construction

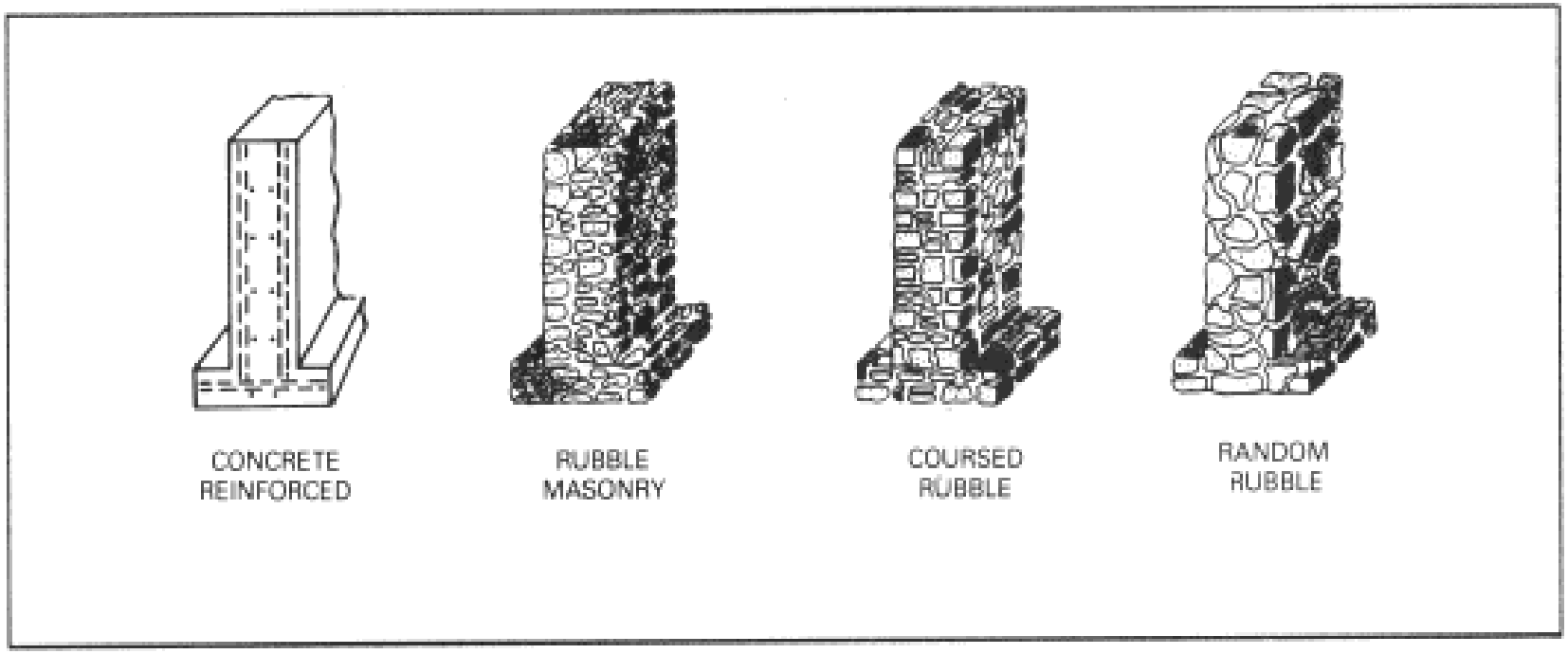
Foundation: Wall Foundations

Coursed rubble is assembled of roughly squared stones in such a manner as to produce approximately continuous horizontal bed joints.

Random rubble is the crudest of all types of stonework. Little attention is paid to laying the stone in courses. Each layer must contain bonding stones that extend through the wall. This produces a wall that is well tied together.

Vertical Construction

Foundation: Wall Foundations



Vertical Construction

Foundation: Wall Foundations

Vertical Construction

Foundation: Column and Pier / Post

The use of post or column foundations constructed from masonry or wood saves time and labor.

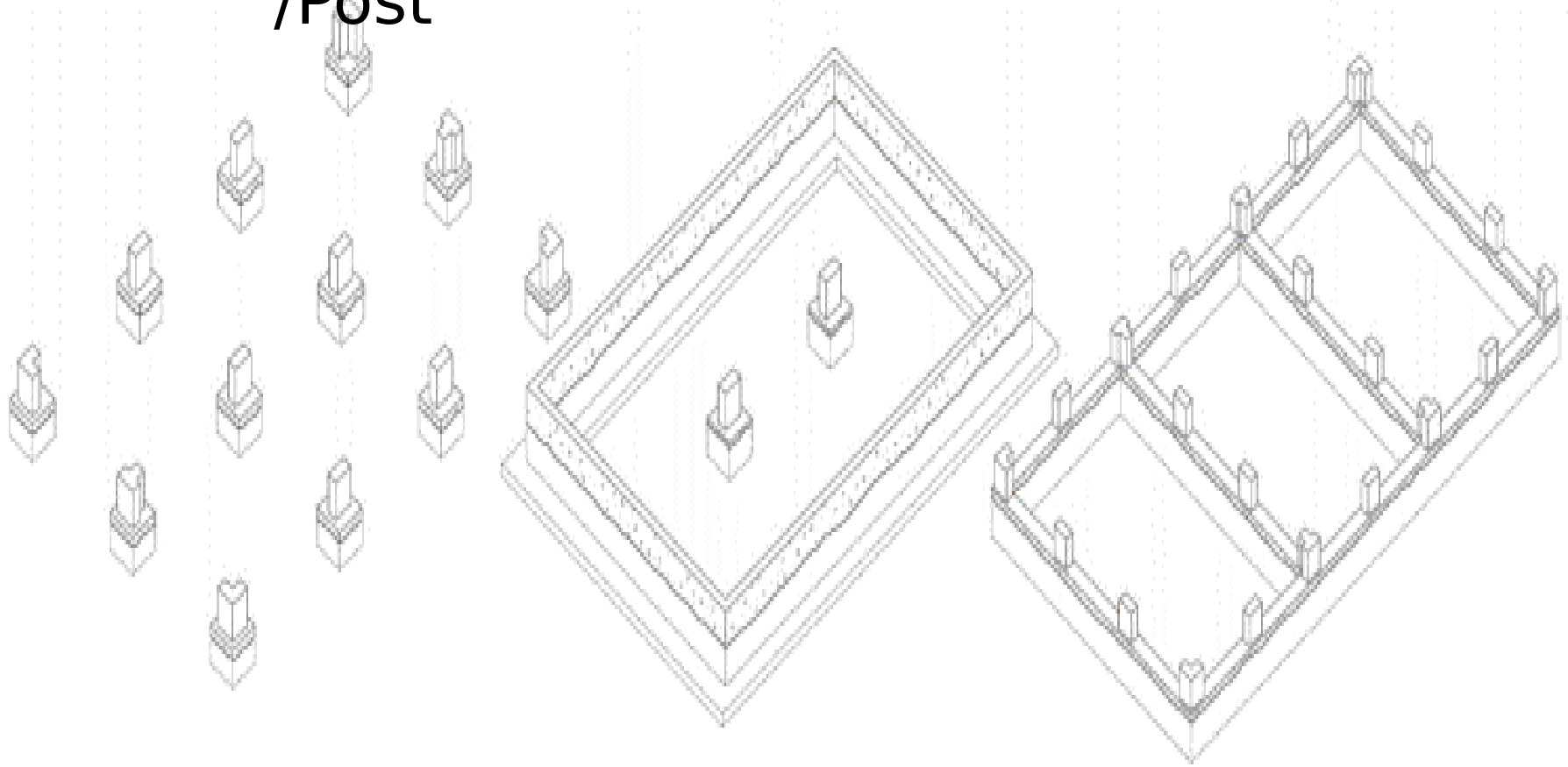
The posts or columns are spaced according to the weight to be carried. In most cases, the spacing is 6 to 10 feet apart.

Wood posts are generally used, since they are installed with the least time and labor.

When wood posts extend 3 feet or more above

Vertical Construction

Foundation: Column and Pier /Post



Vertical Construction

Foundation: Column and Pier /Post

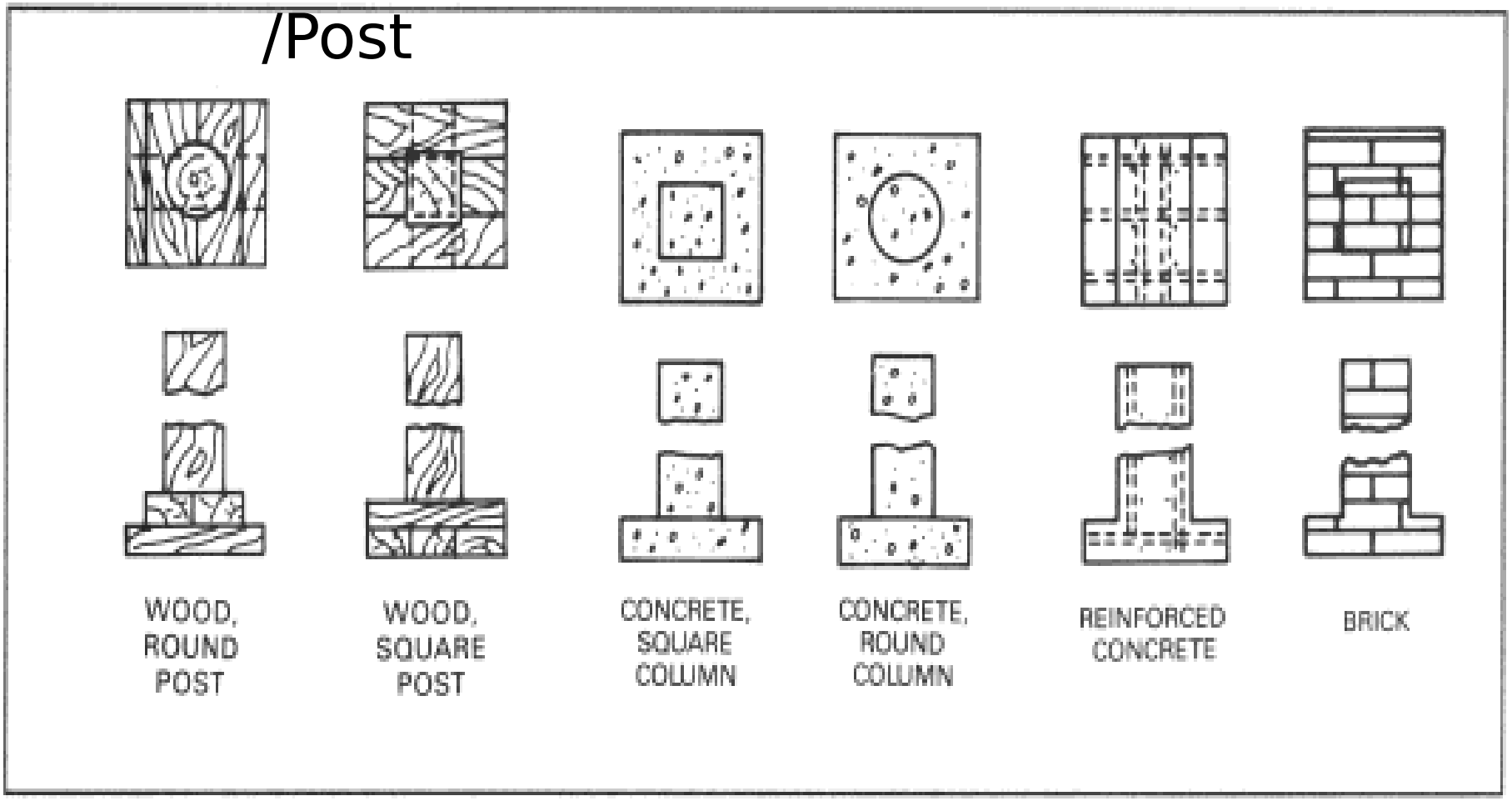


Figure 4-6. Columns and posts

Vertical Construction

Foundation: Column and Pier /Post

Vertical Construction

Splices

Tension-Resistant Splices

In members such as trusses, braces, and joists, the joint undergoes stress in more than one direction; this creates tension, buckling the member in a predictable direction.

Tension resistant splices provide the greatest practical number of bearing surfaces and shoulders within the splice.

Square Splice. This splice is a modification of the compression halved splice. Notches are cut in the tongues or laps to provide an additional locking shoulder. The square splice may be fastened with nails or bolts. **Note**: **It may be greatly strengthened by using fishplates or scabs.**

Long, Plain Splice. This splice is a hasty substitute for the square splice. A long overlap of two pieces is desirable to provide adequate bearing surface and enough room for fasteners to make up for the lack of shoulder lock.

Vertical Construction

Splices

Bend-Resistant Splices

Horizontal timbers supporting weight undergo stress at a splice that results in compression of the upper part; this has a tendency to crush the fibers. Tension of the lower part also tends to pull the fibers apart. Bend-resistant splices resist both compression and tension. Make a bend resistant splice as follows:

Step 1. Cut oblique, complementary laps in the end of two pieces of timber.

Step 2. Square the upper lap (bearing surface) to butt it against the square of the other lap. This offers maximum resistance to crushing.

Step 3. Bevel the lower tongue.

Step 4. Fasten a scab or fishplate along the bottom of the splice to prevent separation of the pieces.

NOTE: **When this splice cannot be done, a butt joint, halved splice, or square splice secured by fishplates or scabs may be used.**

Vertical Construction

Continuous Mud Sill Foundation

Vertical Construction

Floor Frames

SILLS

1. Continuous (Mud Sill)
2. Laminated (Built-up)

- Use a preservative between sill and foundation (termite shields or bldg paper)
- Level sills using wood wedges or grout

Vertical Construction

Sills

- The sill is the foundation that supports a building and is the first part of a building to be set in place.
- It rests directly on the foundation posts or on the ground and is joined at the corners and spliced when necessary.
- The type of sill used depends on the type of construction used in the frame.
- To prevent air from entering into the building, spread a thin bed of mortar on top of the foundation wall. This also provides a solid base for the sill. Another technique is to use a sill sealer made of fiberglass.
- Place insulation material and a termite shield under the sill if desired

Vertical Construction

Sills

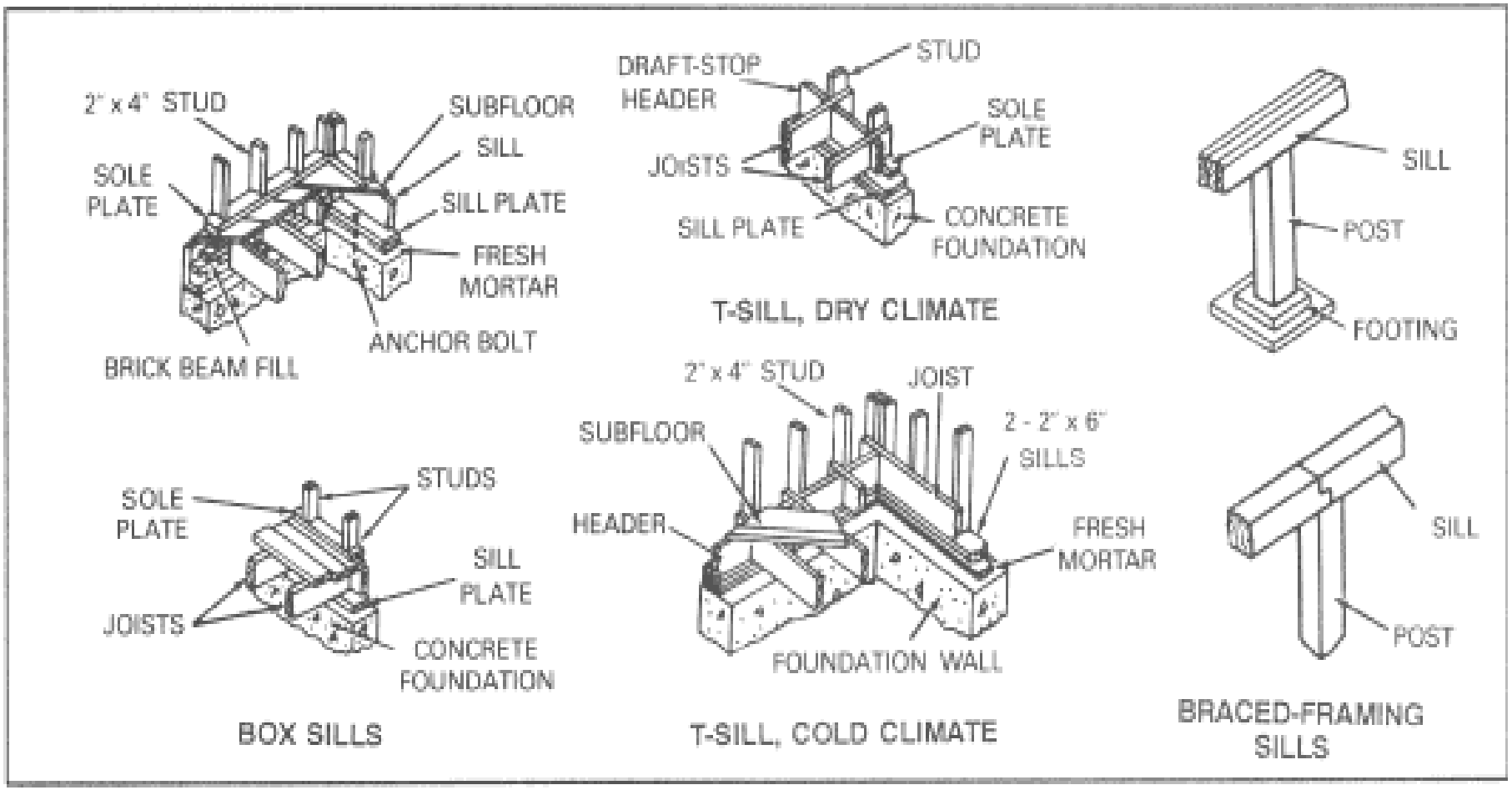
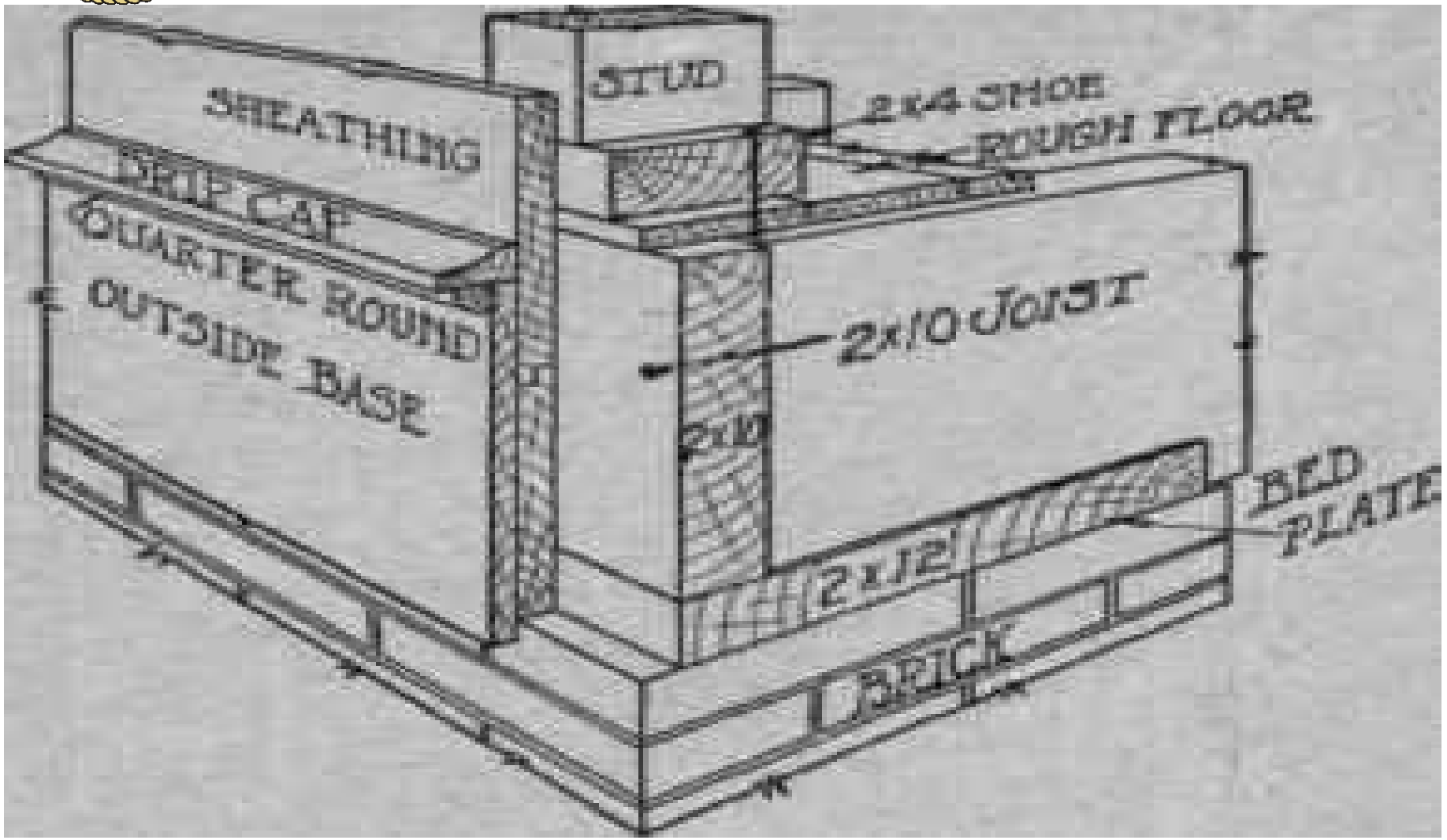


Figure 6-8. Types of sills

Vertical Construction



Vertical Construction
Sills

BUILT-UP SILLS

•If posts are used in the foundation, use either sills made of heavy, single timbers or built-up sills.

•Built-up sills are made with two or more light timbers, such as 2 x 4s.

•A built-up sill is used when heavy, single timbers are not available and lighter lumber (such as a 2 x 4) alone would not support the building load.

•Whether heavy timber or built-up sills are used, the joints should be over posts.

•The size of the sill depends on the load to be carried and the spacing of the posts.

Vertical Construction

Sills

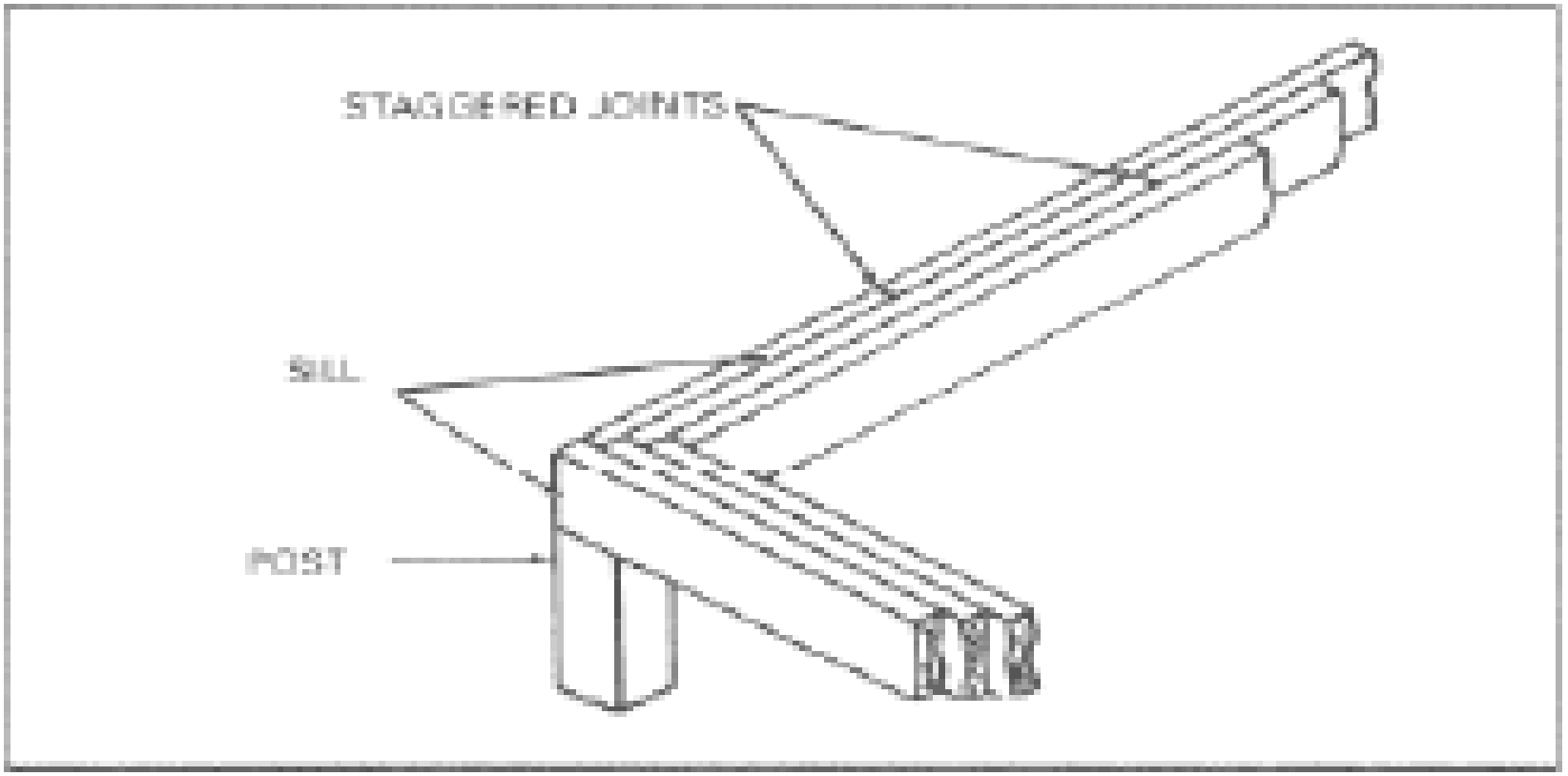
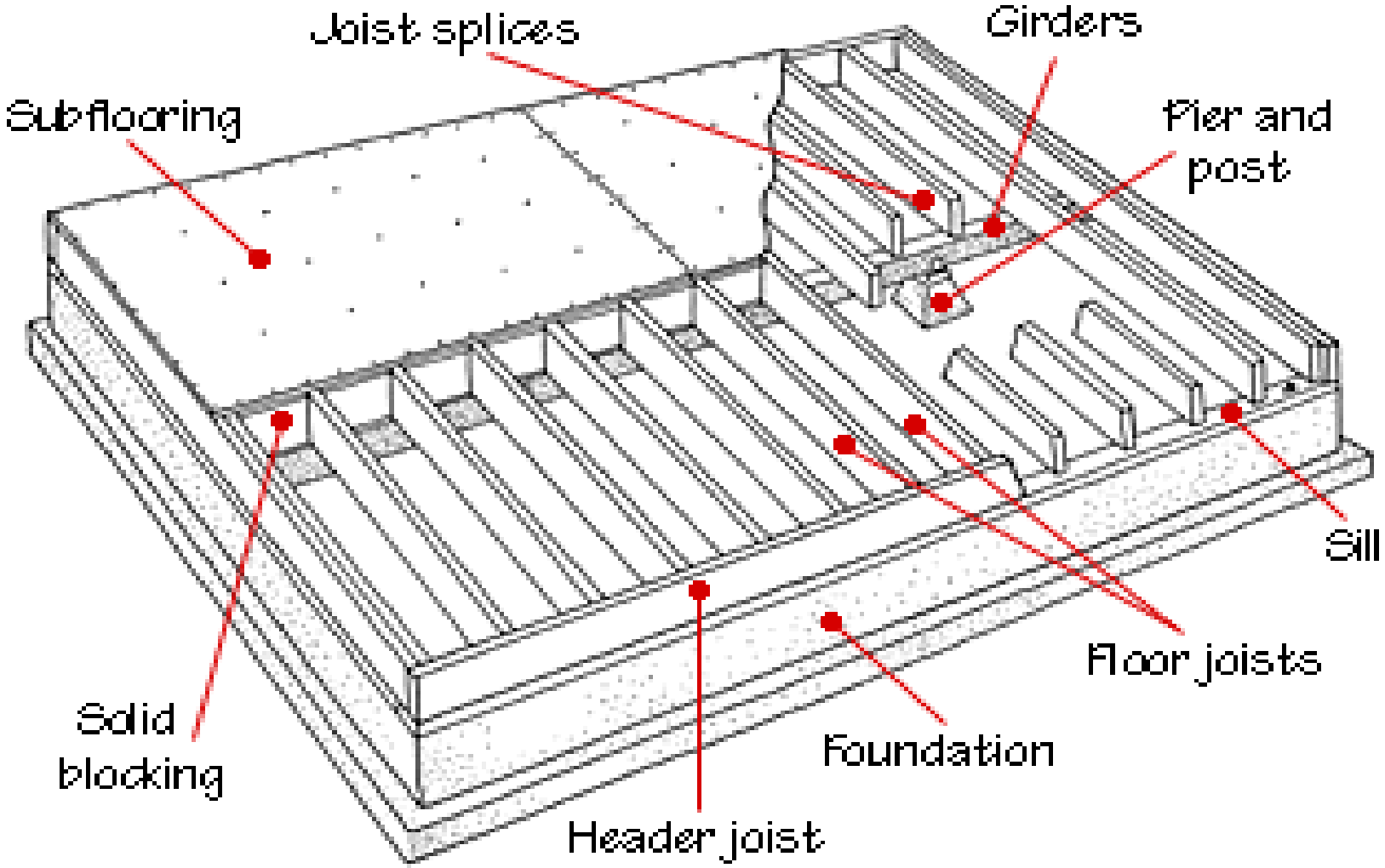


Figure 6-9. Corner joint of a built-up sill

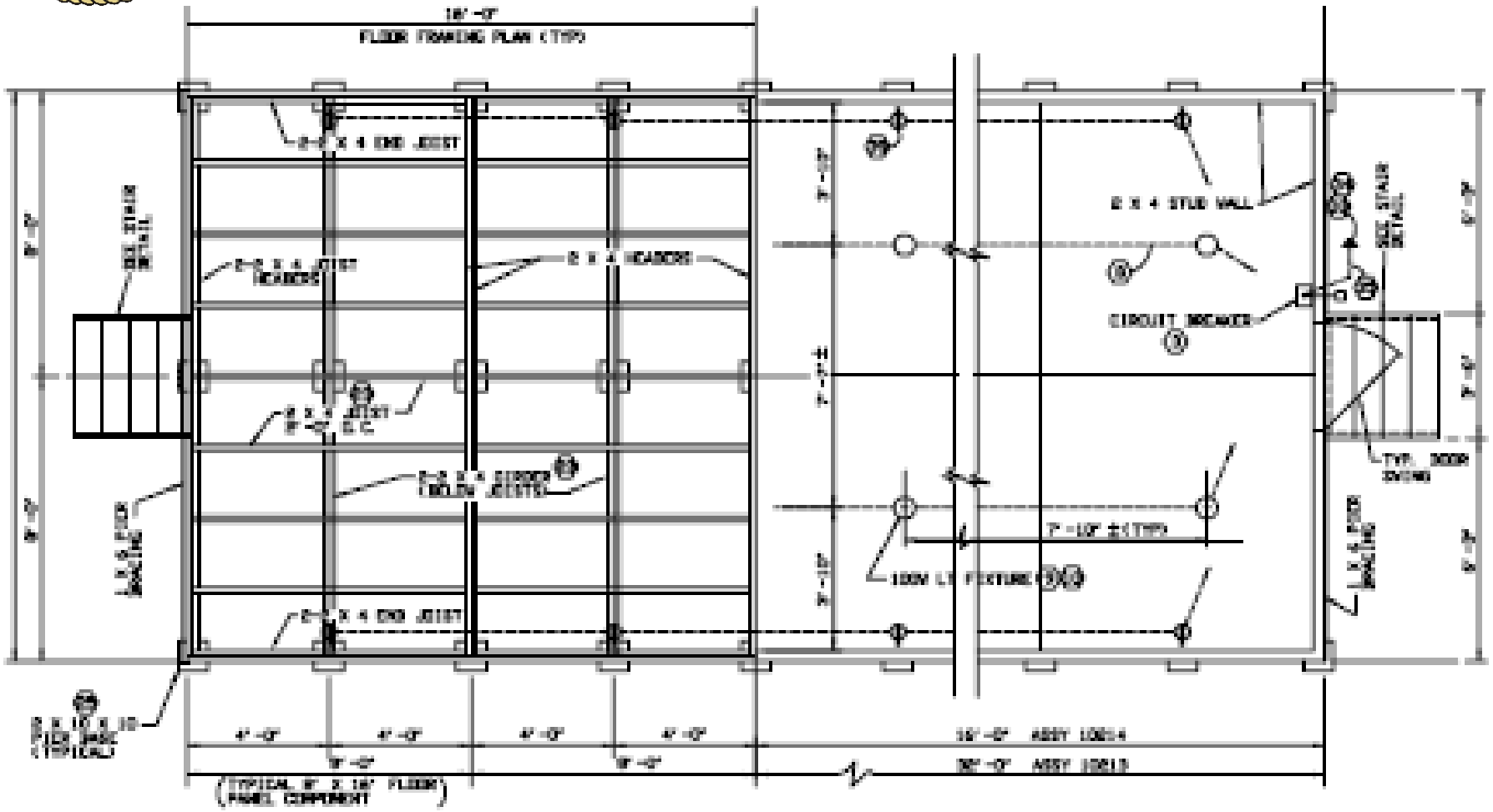
Vertical Construction

Floor Frames



Vertical Construction

Floor Frames

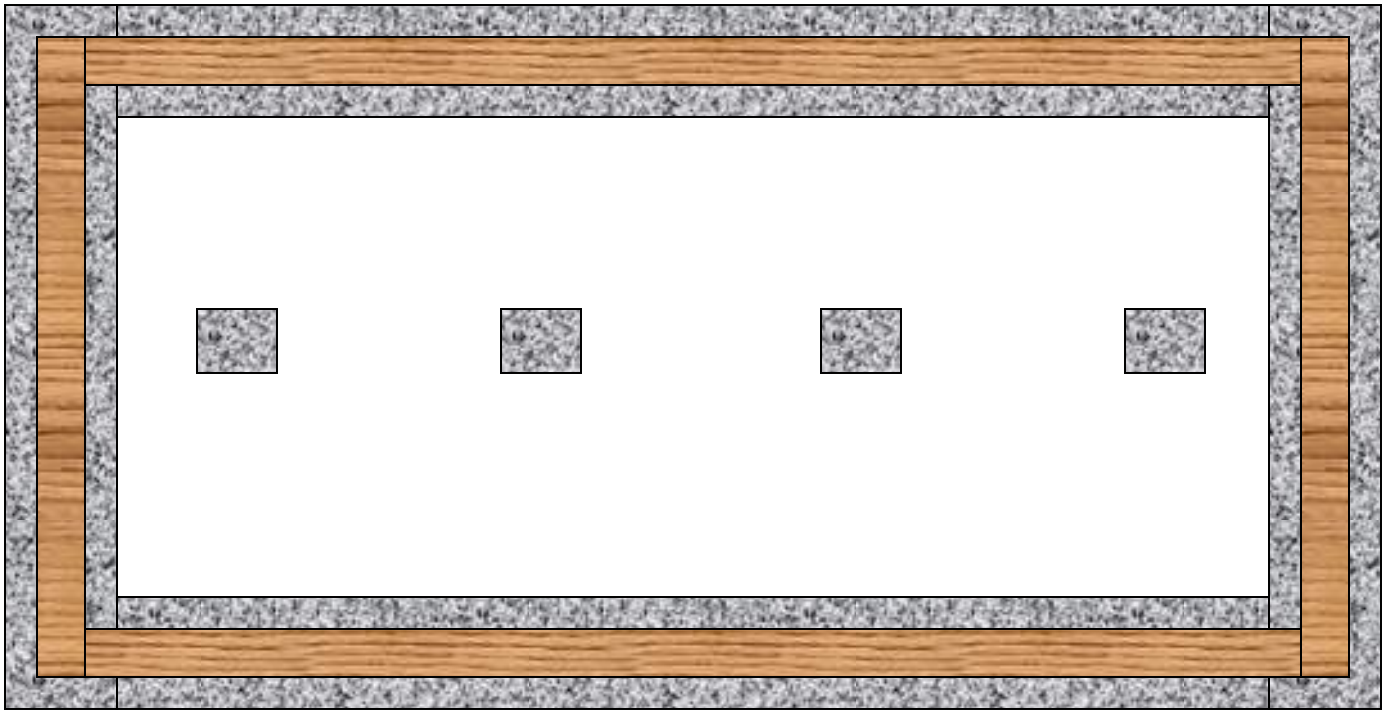


FLOOR AND FLOOR FRAMING PLAN

SCALE 3/8" = 1'-0"

Vertical Construction

Continuous Sill

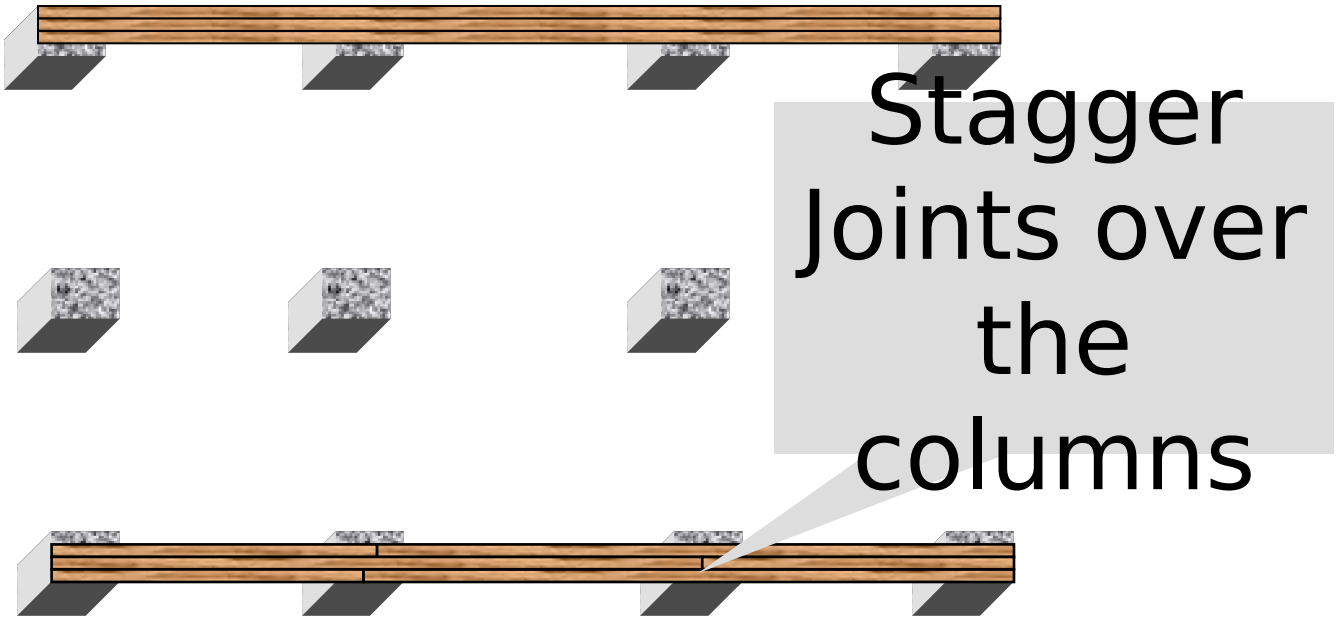


Wall foundation

2” material laid flat around entire length of building

Vertical Construction

Laminated Sill



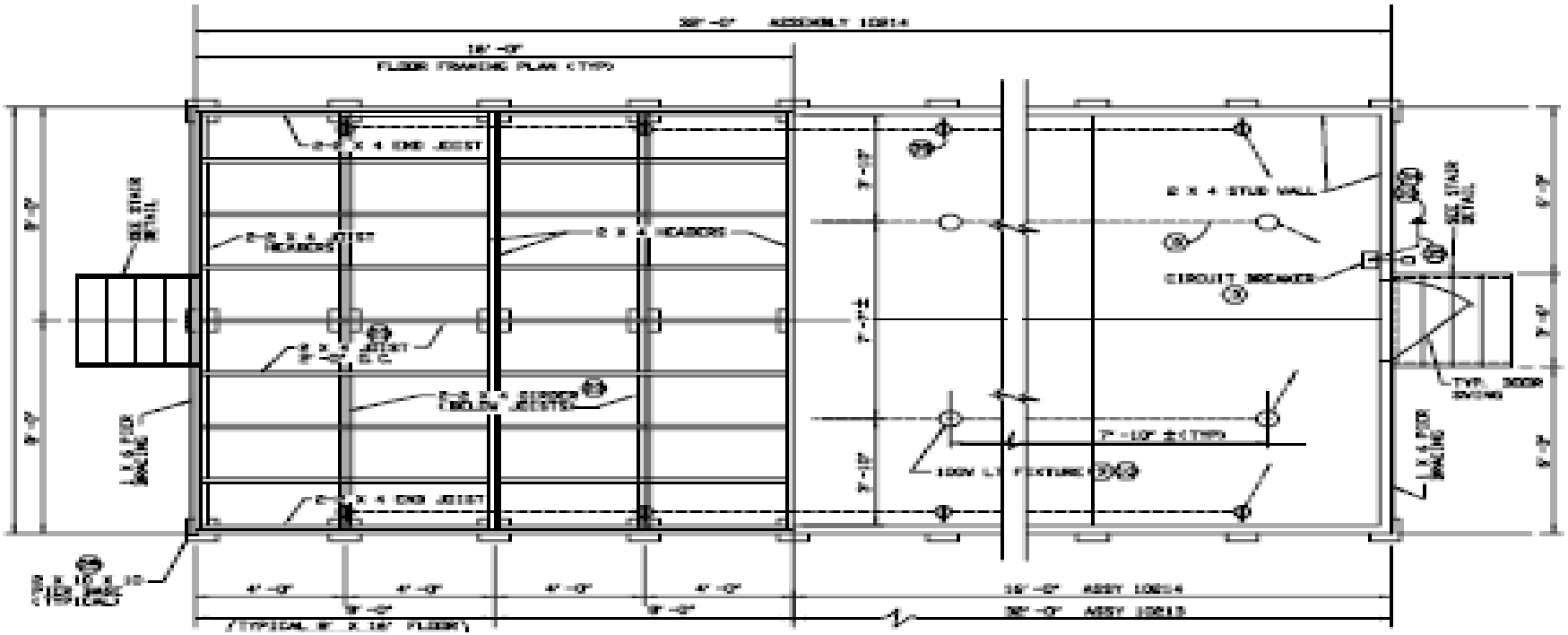
Column & Pier foundation,

2 or more pieces laid on edge and nailed

Vertical Construction

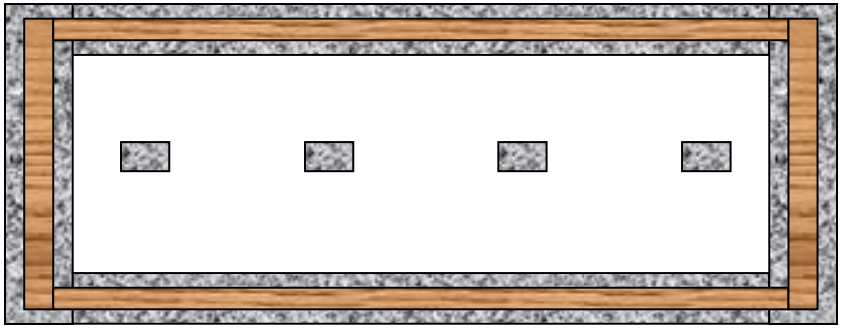
Estimate for sill material

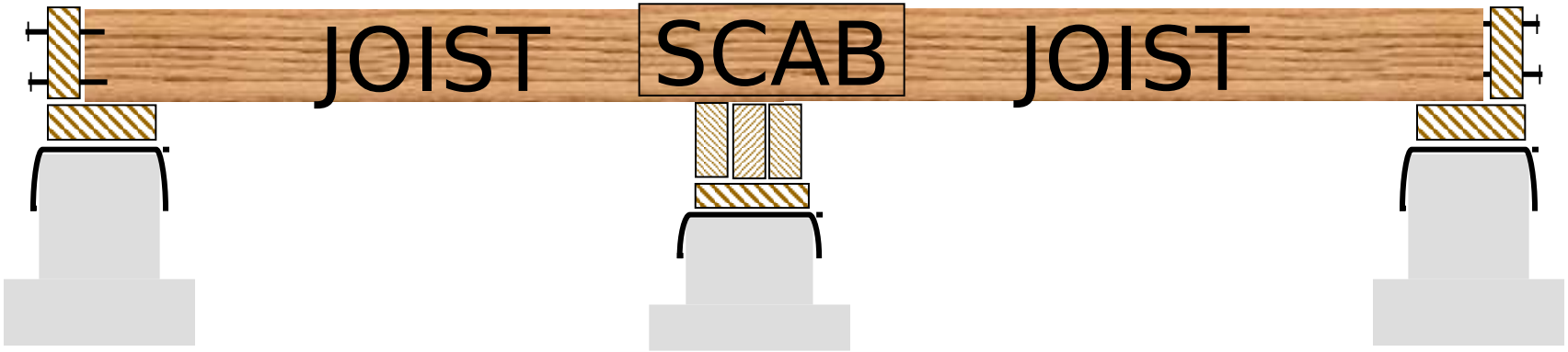
Situation: You are given a building with the following dimensions of 16’ wide and 32’ long. The following sketch and information is provided.



Vertical Construction

Estimate for a Continuous Sill





Vertical Construction

Estimate for a Continuous Sill

Estimate for a continuous sill for a 16’ x 32’ structure

Formula: Total LF divided by Best EOL = # of pieces:				
Bldg Length	32			
Bldg width	16			
Step #1: Determine the perimeter of the bdlg				
perimeter = (l + w) x 2 OR (l + l) + (w + w)				
Bldg perimeter=	96			

Vertical Construction
Estimate for a Continuous Sill

Step #2		
Determine EOL		
Rule #2		
TLF	EOL	# of pieces
96	16	6
96	14	6.85
96	12	8
96	10	9.6
96	8	12

Step #3			
Determine Waste			
# of pieces	waste factor		round up
6	1.1	6.6	7
6.85	1.1	7.535	8
8	1.1	8.8	9
9.6	1.1	10.56	11
12	1.1	13.2	14

Step #4				
Convert to board Feet				
EOL				
	thickness	width	length	
# of pieces				BF
7	2	8	16	149.33

Vertical Construction

Estimate for a Laminated Sill

Vertical Construction

Estimate for a Laminated Sill

Laminated Sill Estimation		
Step #1: Determine the Best EOL		
Bldg length / ALL EOL		
Bldg length	EOL	
32	16	2
32	14	2.28
32	12	2.66
32	10	3.2
32	8	4

Step #2: Determine the Total Pieces required
Bldg length ÷EOL =1/3 OF SILL

bldg length	EOL	1/3 of sill	Round if necessary	#of laminates	#of Pieces	#of Sills	Total #of Pieces
32	16	2	2	3	6	4	24
32	14	2.2857142	3	3	9	4	36
32	12	2.6666666	3	3	9	4	36
32	10	3.2	4	3	12	4	48
32	8	4	4	3	12	4	48

Step #3: Determine Waste

Total #of Pieces	Waste Factor		Round up as Required
24	1.1	26.4	27

Step #4: Convert to Board Feet

Qty	thickness	Width	Length	Constant	Board Feet
27	2	8	10	12	360

Vertical Construction

Girder

The distance between two outside walls is usually too great to be spanned by a single joist.

A *girder is* used for intermediate support when two or more joists are needed to cover the span.

A girder is a large beam that supports other smaller beams or joists.

A girder may be made of timber, steel, reinforced concrete, or a combination of these materials.

Vertical Construction

Girder

Wooden girders are more common than steel in light-frame buildings. Built-up and solid
girders should be of seasoned wood.

Common types of wood girders include solid, built-up, hollow, and glue-laminated. Hollow beams resemble a box made of 2 x 4s, with plywood webs.

Often called box beams, built-up girders are usually made of several pieces of framing lumber. Built-up girders warp less easily than solid wooden girders and are less likely to decay in the center.

Girders carry a large part of the building weight. They must be rigid and properly supported at the foundation walls and on the columns. They must be installed properly to support joists. The ends of wood girders should bear at least 4 inches on posts.

CAUTION Precautions must be taken to avoid or counteract any

Vertical Construction

Girder

Girder Depth that is doubled will increase the safe load by four times

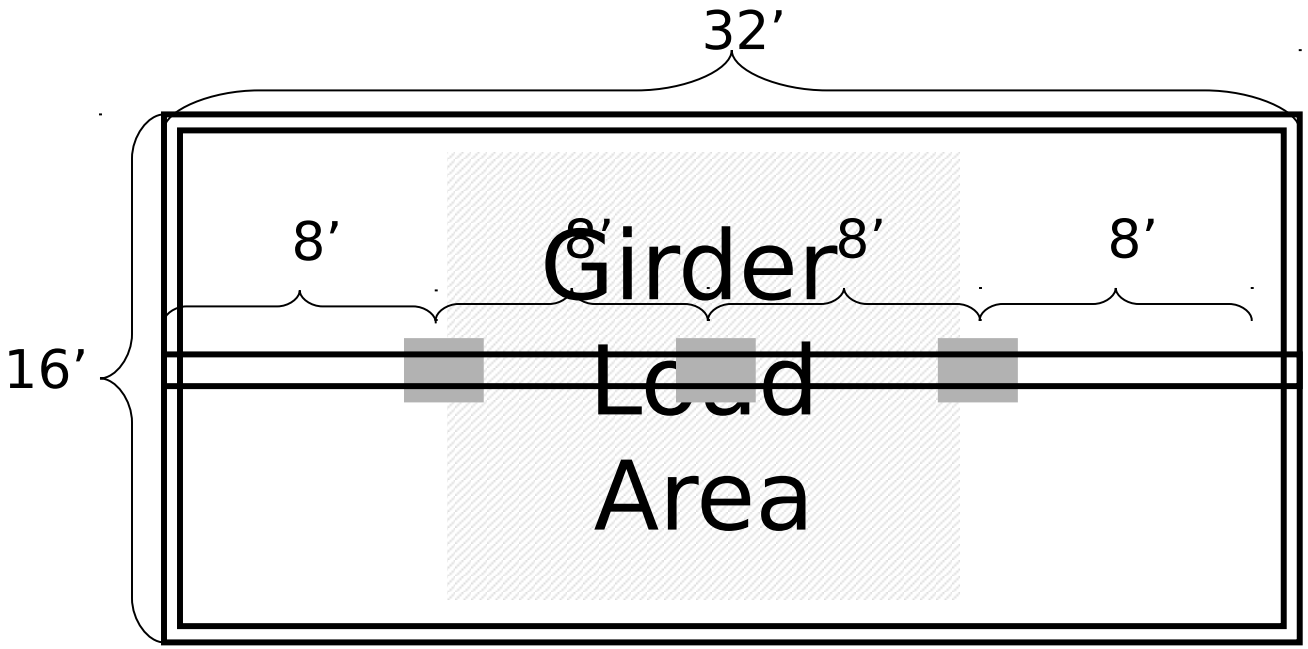
Size requirements determined by girder principles:

- Distance between girder post
- Girder load area
- Total floor load on girder per ft^2
- Material to be used

Vertical Construction

Girder

The building load is carried by the outside walls and the girder supports twice as much load



Vertical Construction

Girder

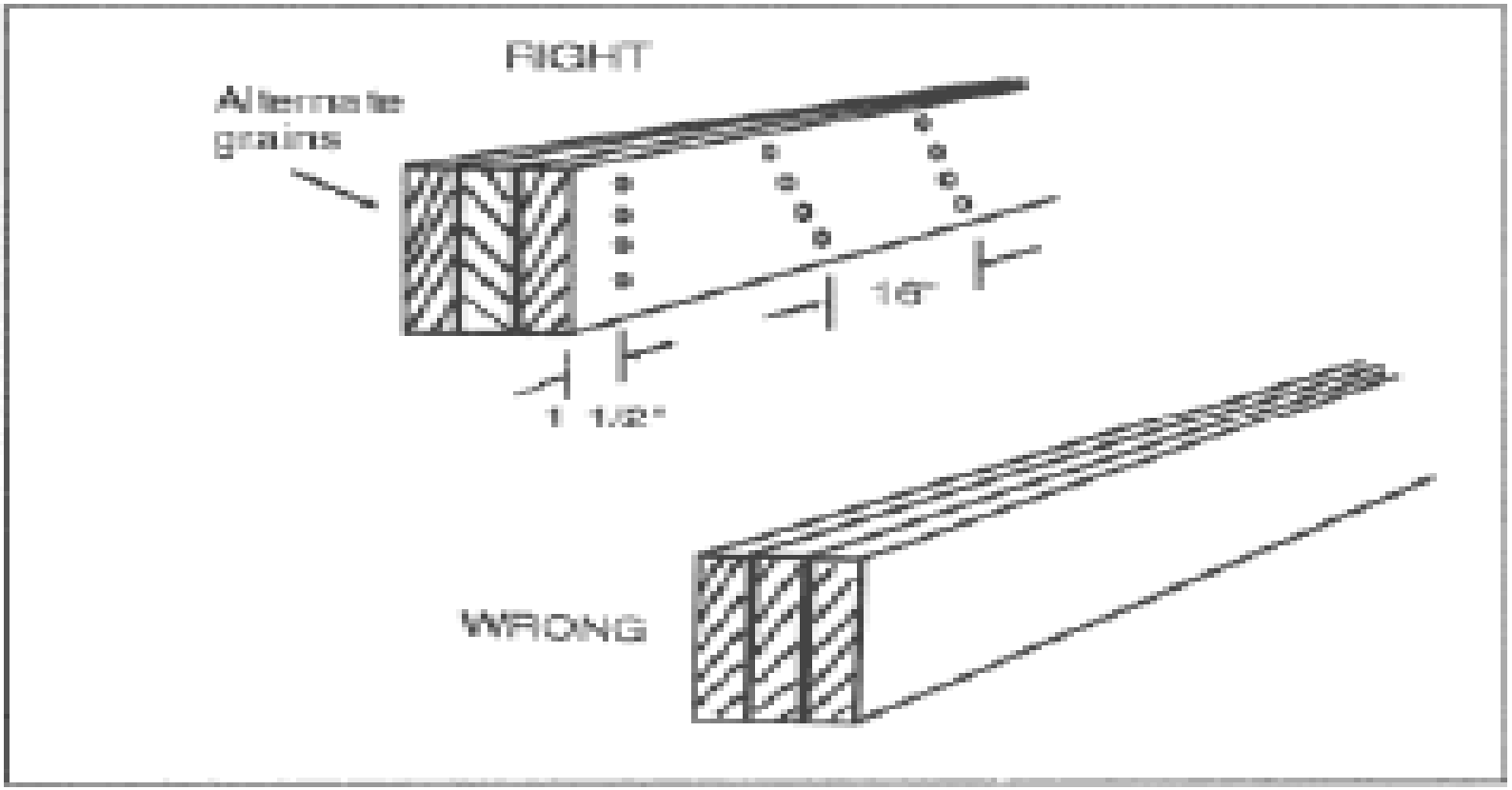
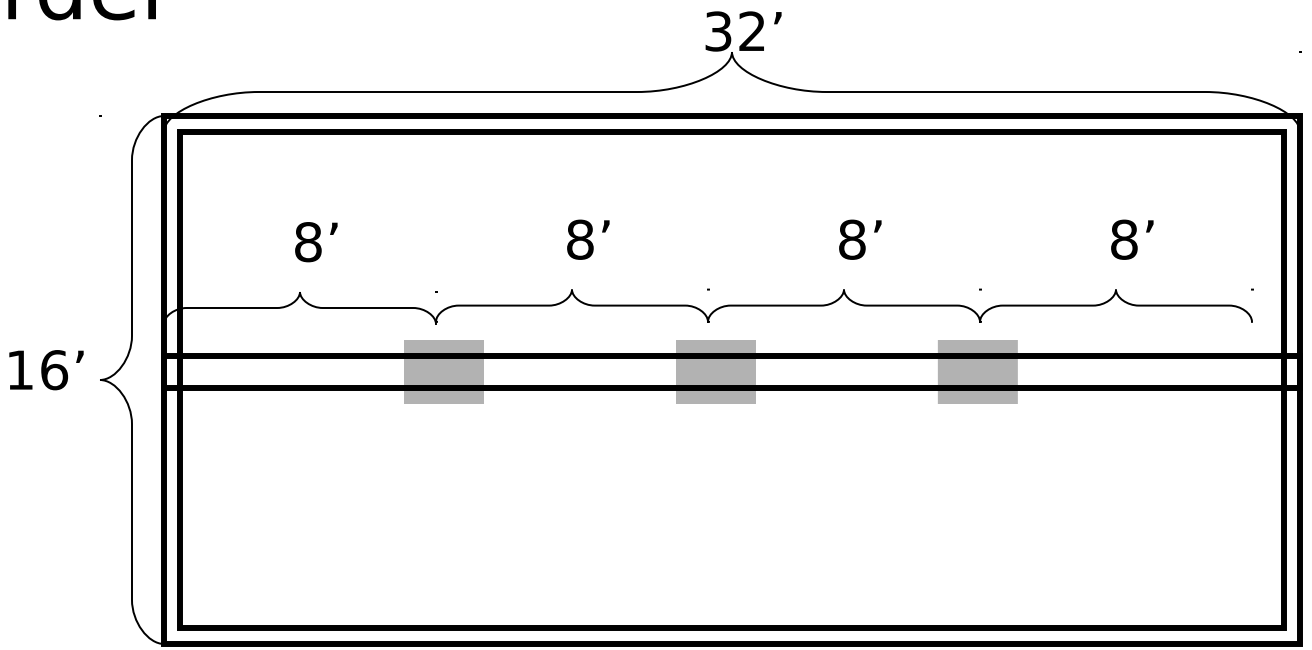


Figure 6-13. Built-up girder lumber arrangement

Vertical Construction

Girder

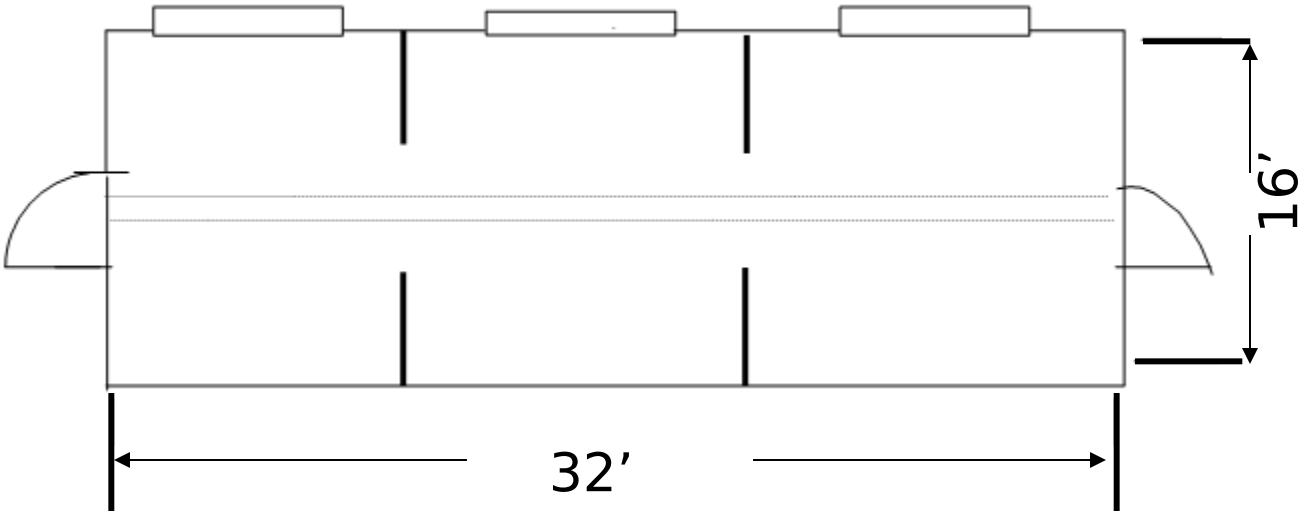


NOTE: When locating columns that must support girders, avoid spans of more than 10 feet between columns. The farther apart columns are spaced, the heavier the girder must be to carry the joists over the span between the columns.

Vertical Construction

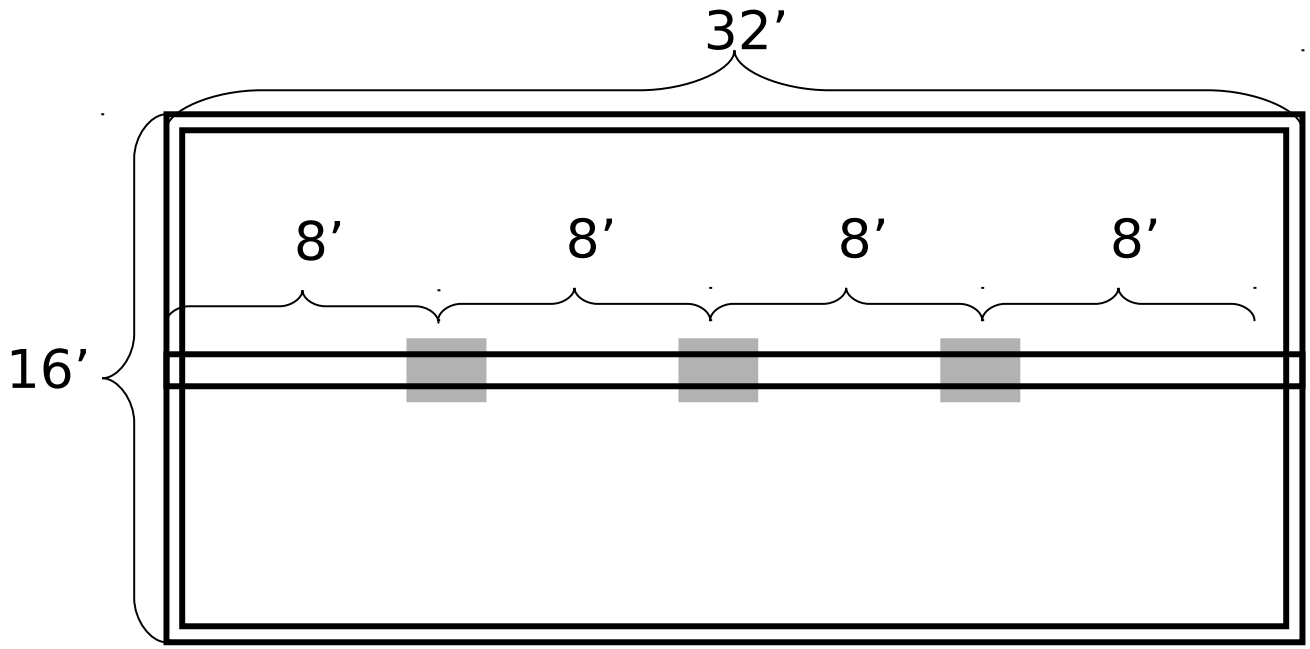
Estimate Girder Material

Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

Estimate for a laminated Girder



Vertical Construction

Estimate for a laminated Girder

Pier foundation: pier spacing 10’

This girder is laminated 4 times

step #1: Determine EOL
bldg length / all EOL
Rule #2

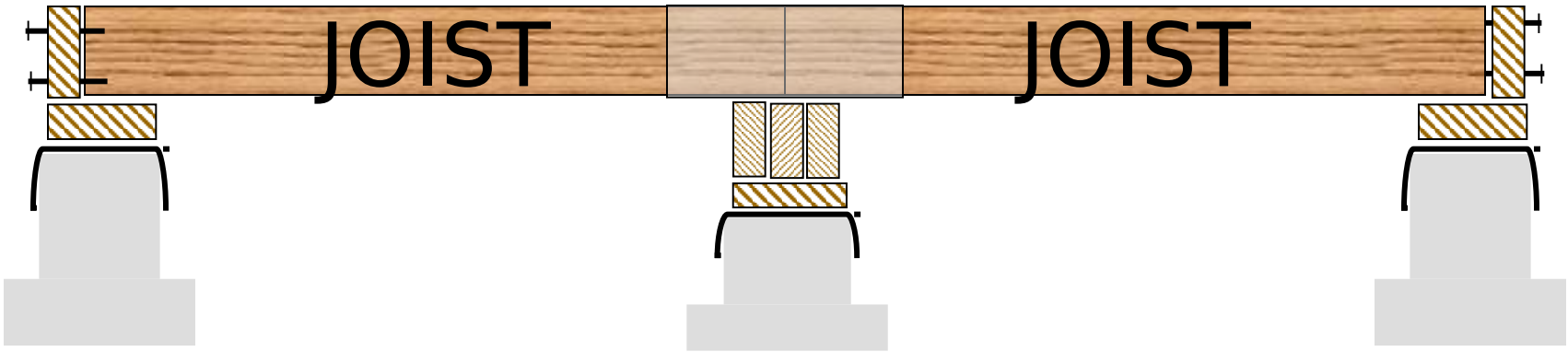
Bldg Length	EOL	
32	16	2
32	14	2.285714286
32	12	2.666666667
32	10	3.2
32	8	4

Step #2: Estimate for the entire girder	
1/4 of girder =	2
number of laminates	4
total for girder	8

Step #3: Determine Waste	
total pieces for girder =	8
waste factor =	1.1
total pieces plus waste =	8.8
round up	9

Step #4: Calculate Board feet				
#of pieces	thickness	width	length	board feet
9	2	8	16	192

Vertical Construction



Vertical Construction

Estimate for Floor joists

-makes up the body of the floor frame

-carry live load and dead load

-distributes load to girder and sills

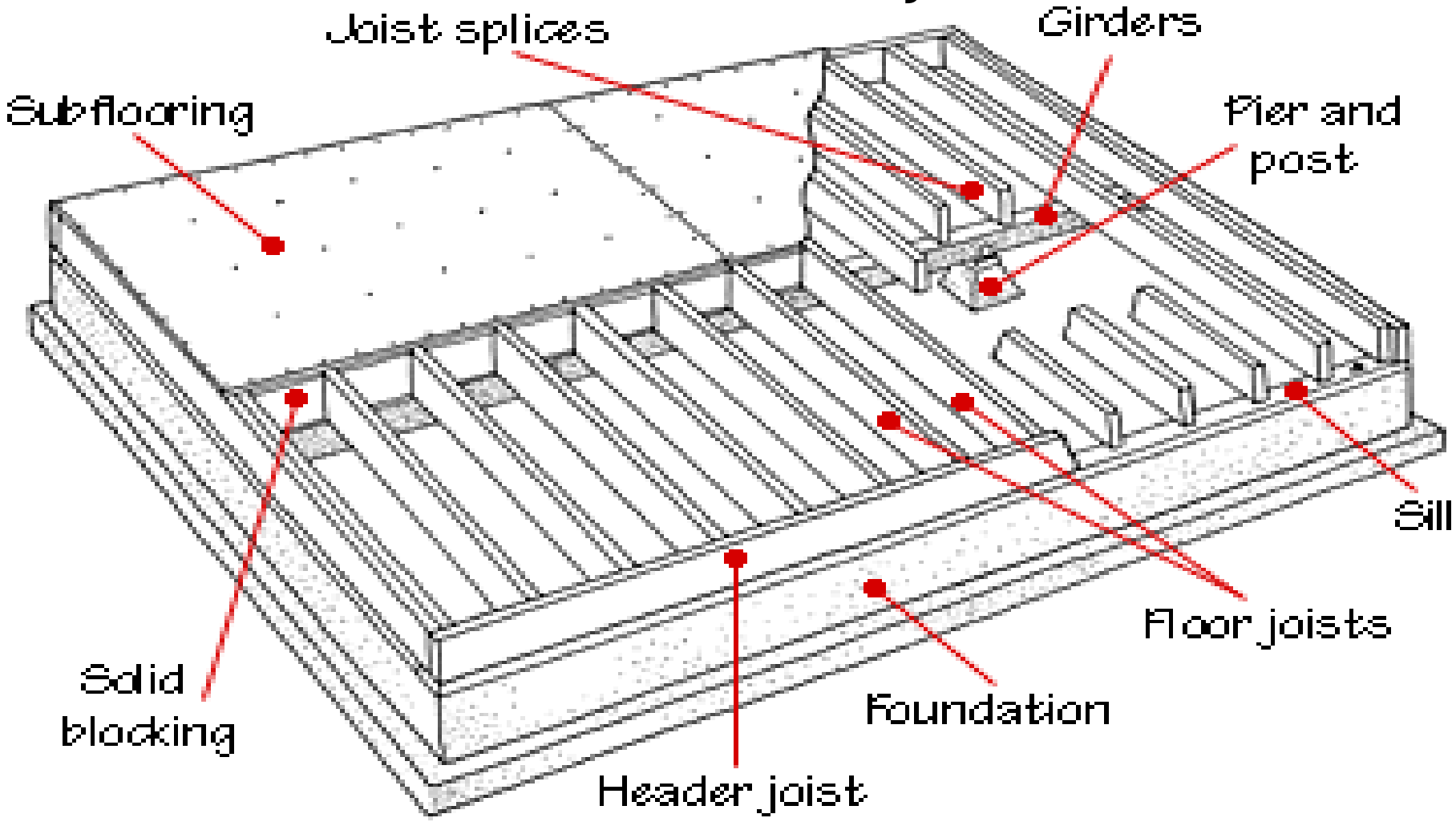
-on center (o.c. or o/c) spacing either 16”, 24” and for heavy loads it may be 12”

-always place on edge with crown facing up

-in certain parts of floor it is necessary to double floor joists; known as trimmer joists

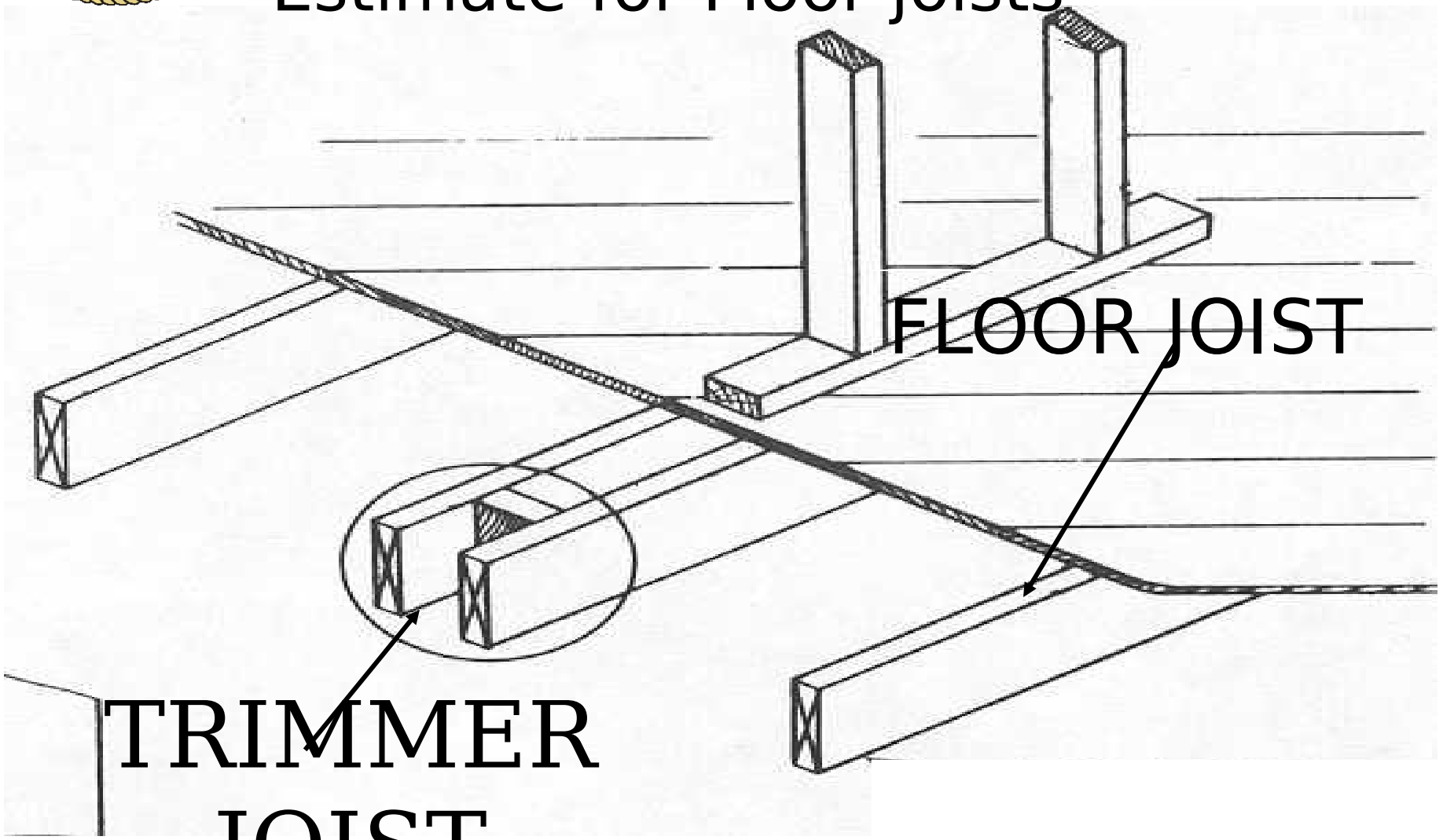
Vertical Construction

Estimate for Floor joists



Vertical Construction

Estimate for Floor joists

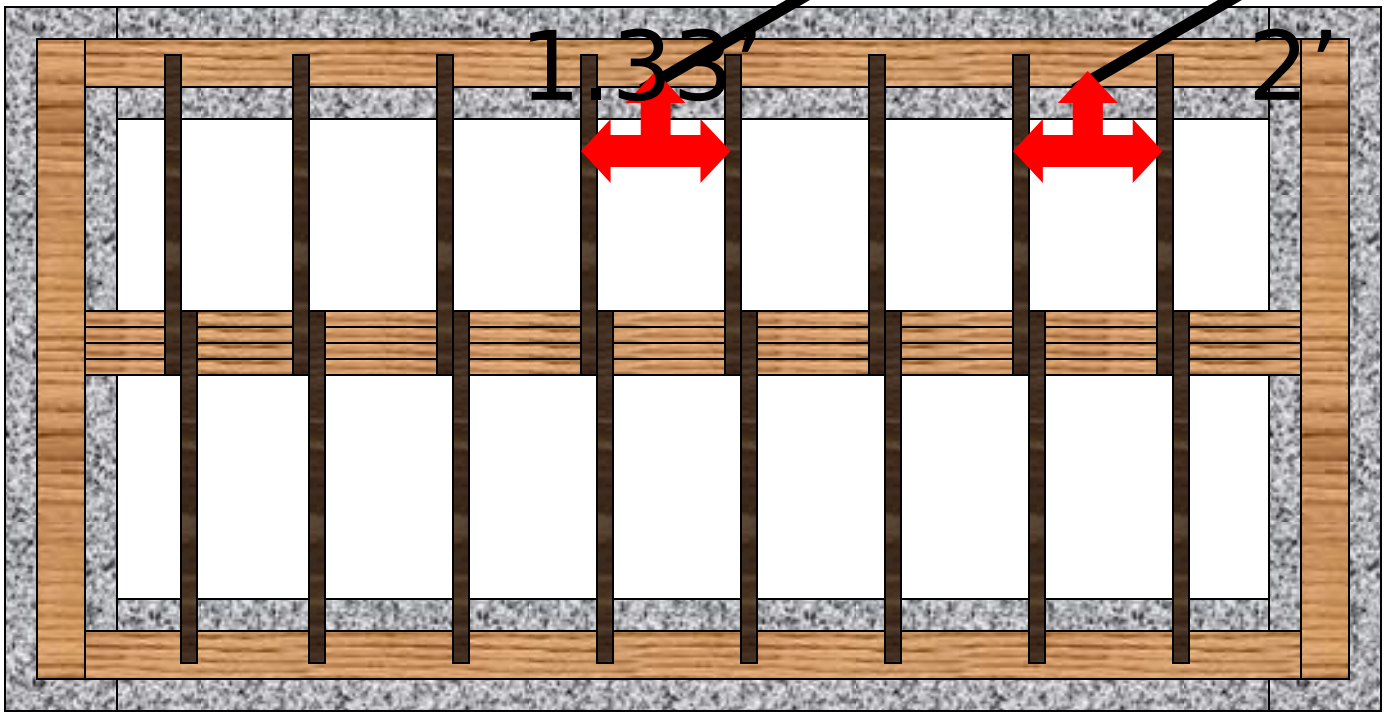


Vertical Construction

Estimate for Floor joists

Proper interval; O/C spacing. Measured from center of one joist to center of next joist

16” = 1.33’ or 24” = 2’



Vertical Construction

Floor joists

Methods of connecting:

1. Resting on top of sill or girder

- if butt spliced on girder, joint must be scabbed

- must be cut long enough to extend full width of sill of girder

2. Ledger Plate - nailed to the face with bottom edge flush with bottom of sill or girder. Do not notch more than 1/3 of depth

3. Metal fasteners – strongest joist supports

Vertical Construction

Estimate for Floor joists

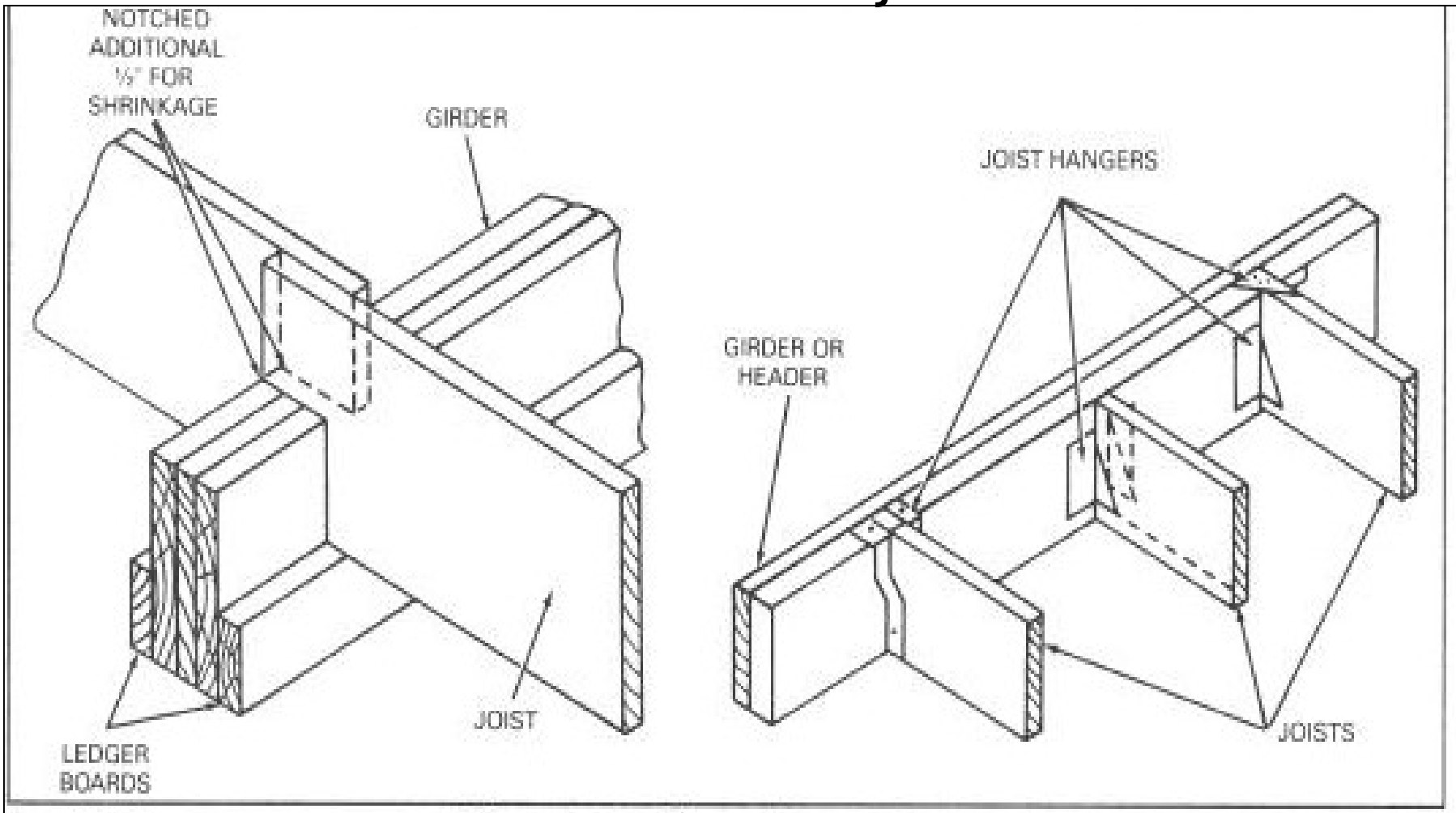
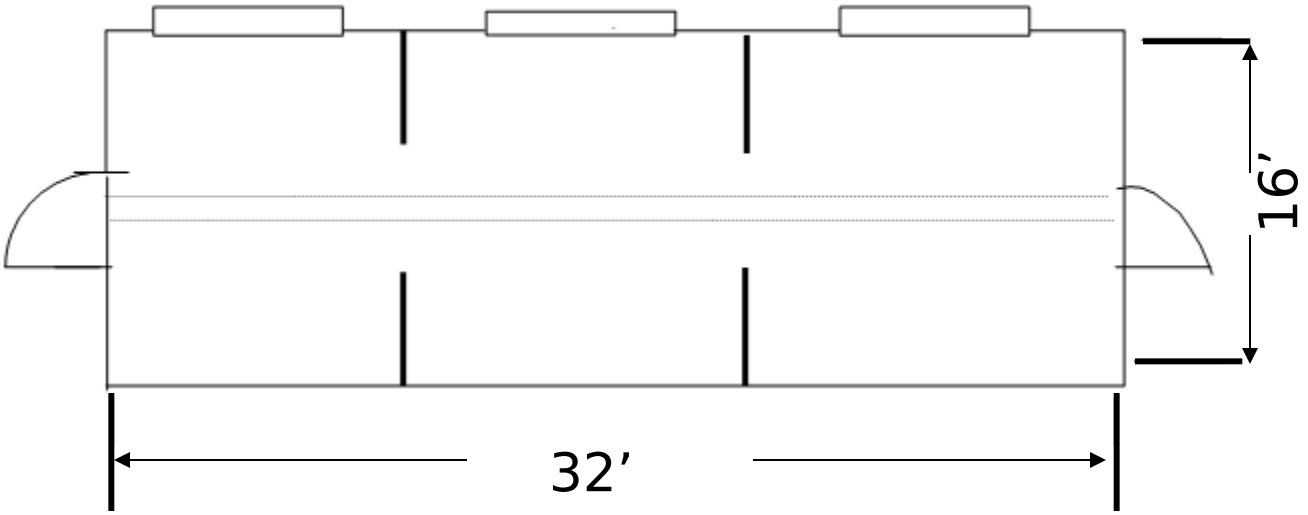


Figure 6-11. Joist-to-girder attachment

Vertical Construction

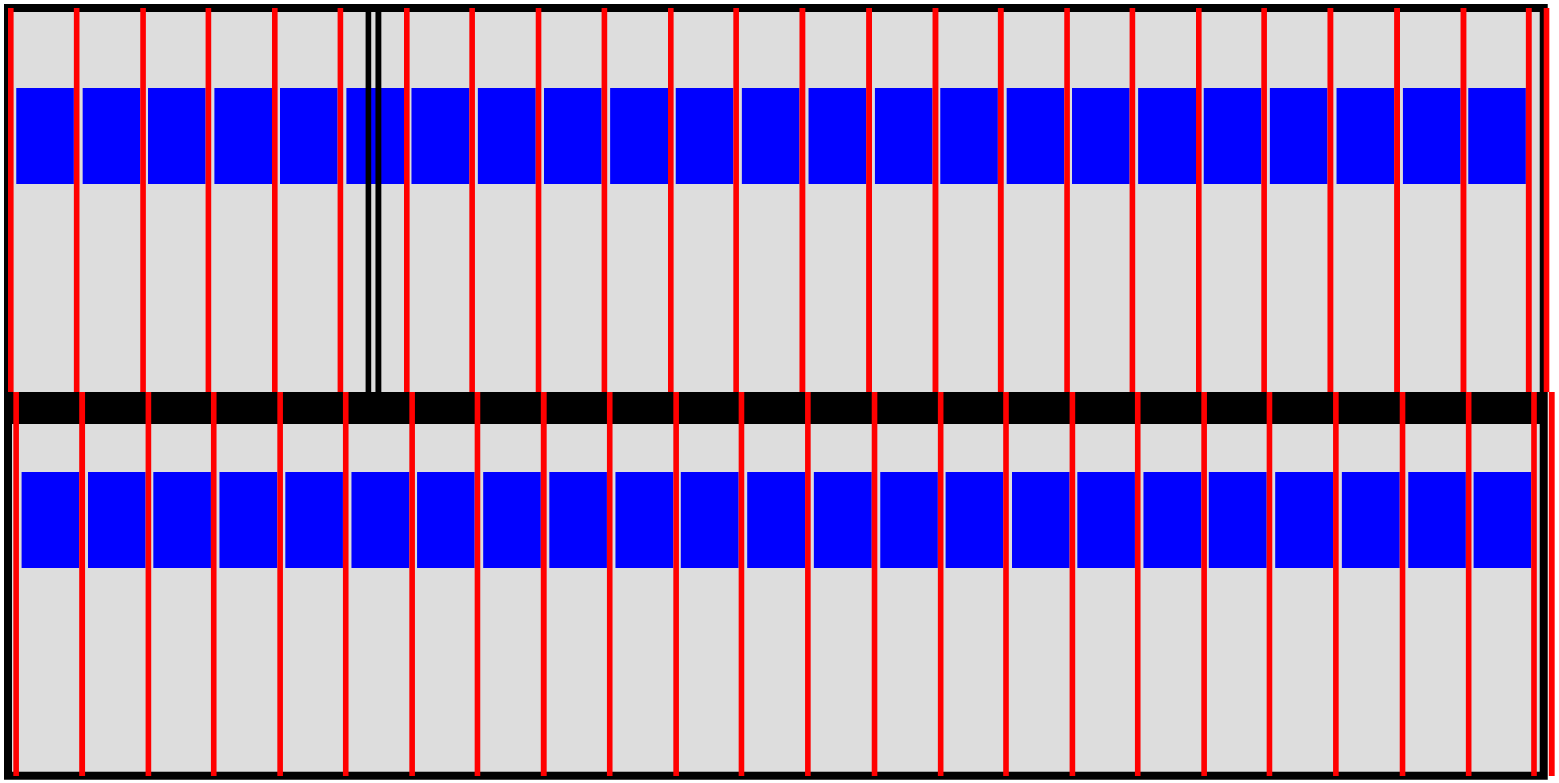
Floor joists

Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

	Length of wall (in feet)	constant	Trimmer	# of partitions	# of Joists	x 2 to capture entire bldg	x waste	Round up
Number of Joists =	32	0.75	1	2	27	54	59.4	60
calculate for board feet	QTY	T	W	L	constant	board feet		
	60	2	8	16	12	1280		

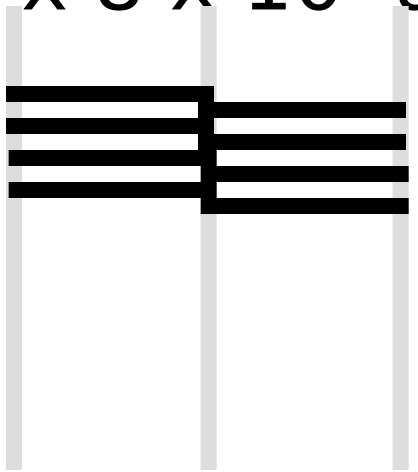


Vertical Construction

Estimate for Floor joists

Determine EOL RULE 1

EOL predetermined by the width of the building and how the joists are connected to the girder. Since the width of the building is 16’ wide and the joists are plain lapped on girder, 2 x 8 x 10’ are used



Vertical Construction

Estimate for Header joists

Header is the same length as the bldg and forms a “box” that encases the [floor] joists.

Use the same size material as the floor joists

There are 2 headers, one on each [32’]side of the bldg

Vertical Construction

Estimate for Header joists

Step 1: Determine Best EOL	EOL	Bldg Length				
	16	32	2			
	14		2.285714			
	12		2.666667			
	10		3.2			
	8		4			
Step 2: multiply by number of headers	Best EOL	Number of sides to cover		x waste	round up	
	2	2	4	4.4	5	
Step 3: Covert to board feet	QTY	T	W	L	constant	Board Feet
	5	2	8	16	12	106.6667

Vertical Construction

Estimate for Bridging

Bridging is used between the joists to stiffen the floor frame.

Two types:

-HORIZONTAL / SOLID (SAME MATERIAL AS JOISTS)

-CROSS (1X3 OR 2X4)

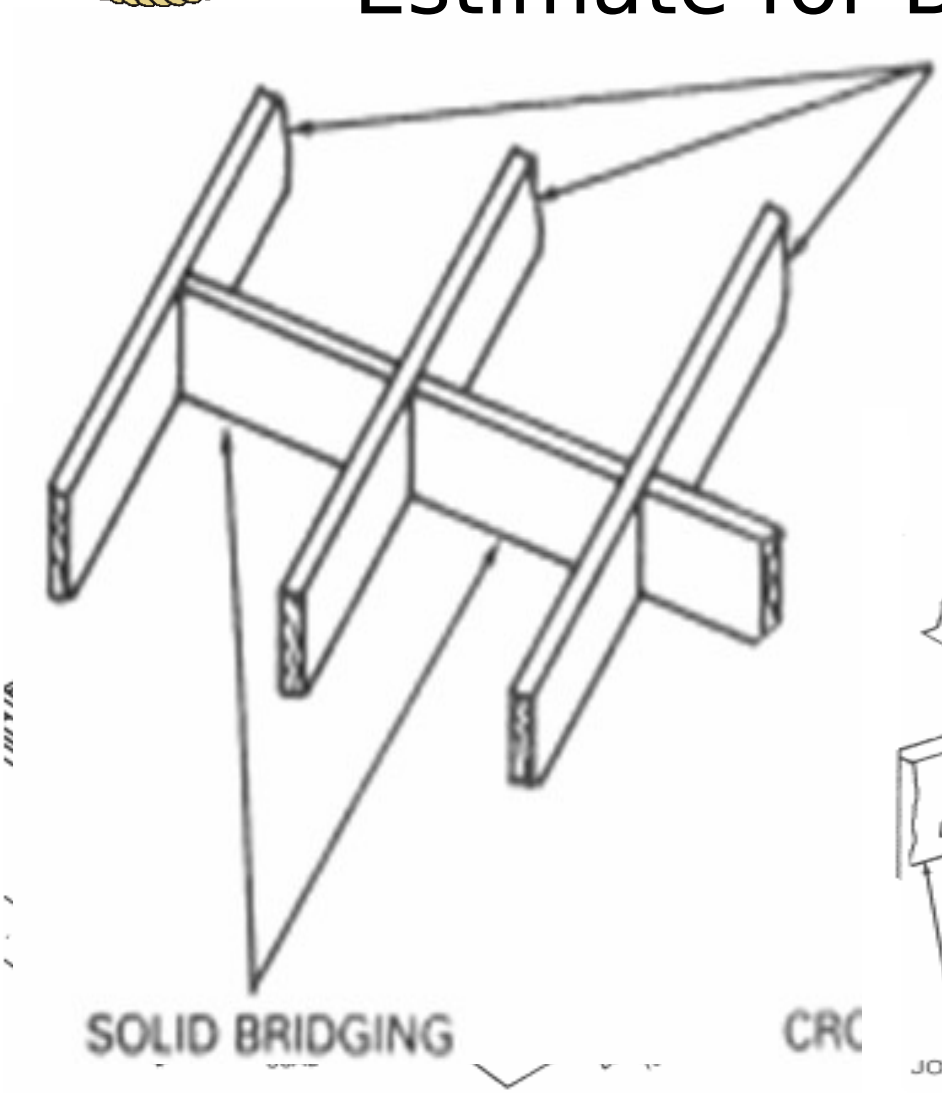
NOTE: Joists over 8’ = 1 row

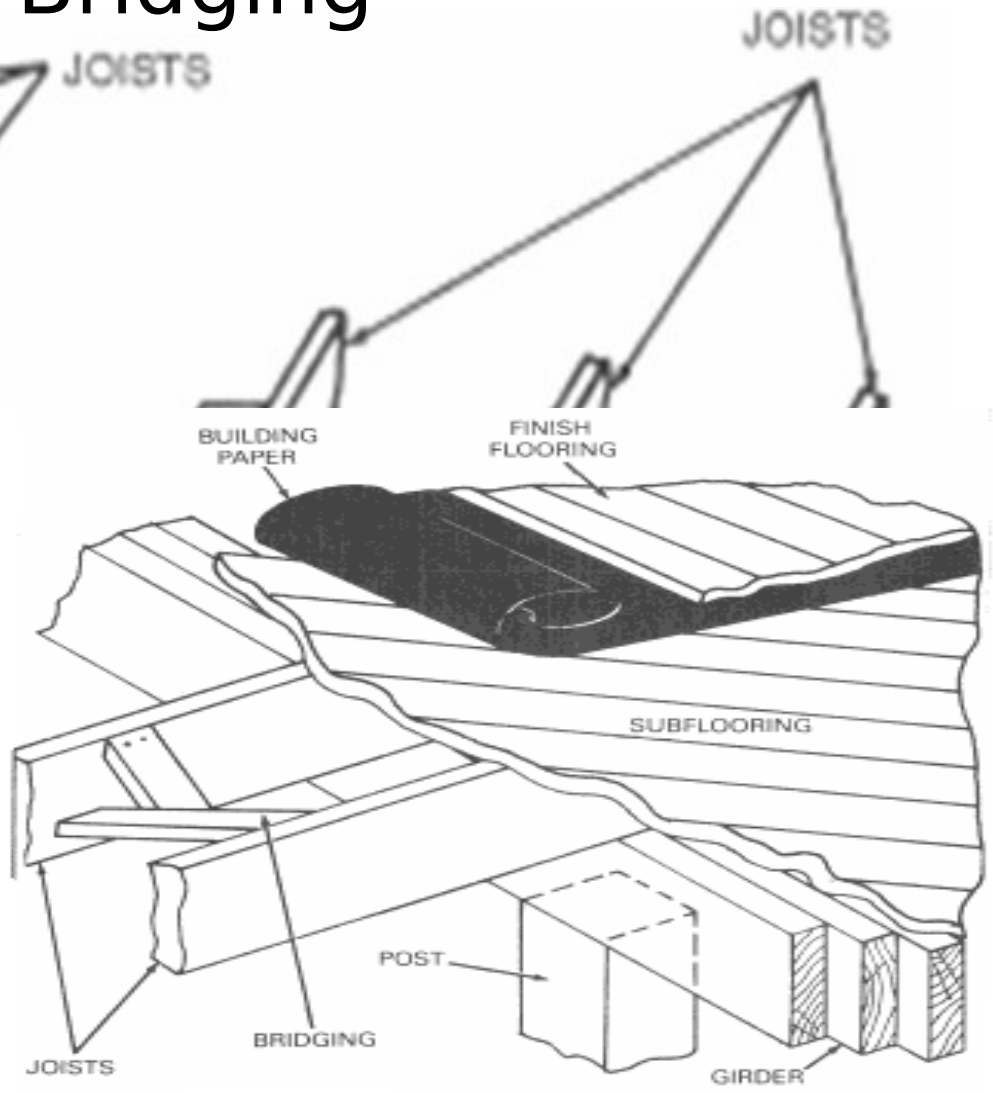
Joists over 16’ = 2 Rows

Vertical Construction

Vertical Construction

Estimate for Bridging





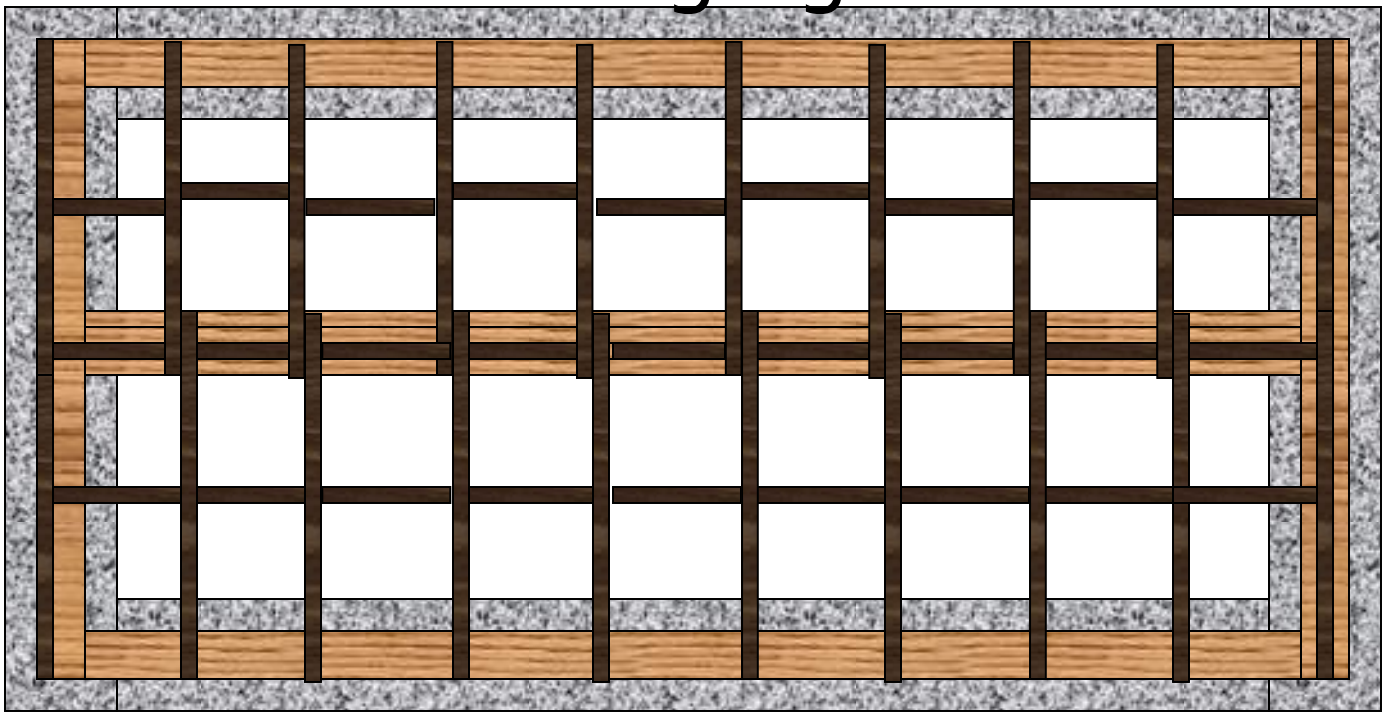
Vertical Construction

Estimate for Bridging

ROW 1

ROW 2

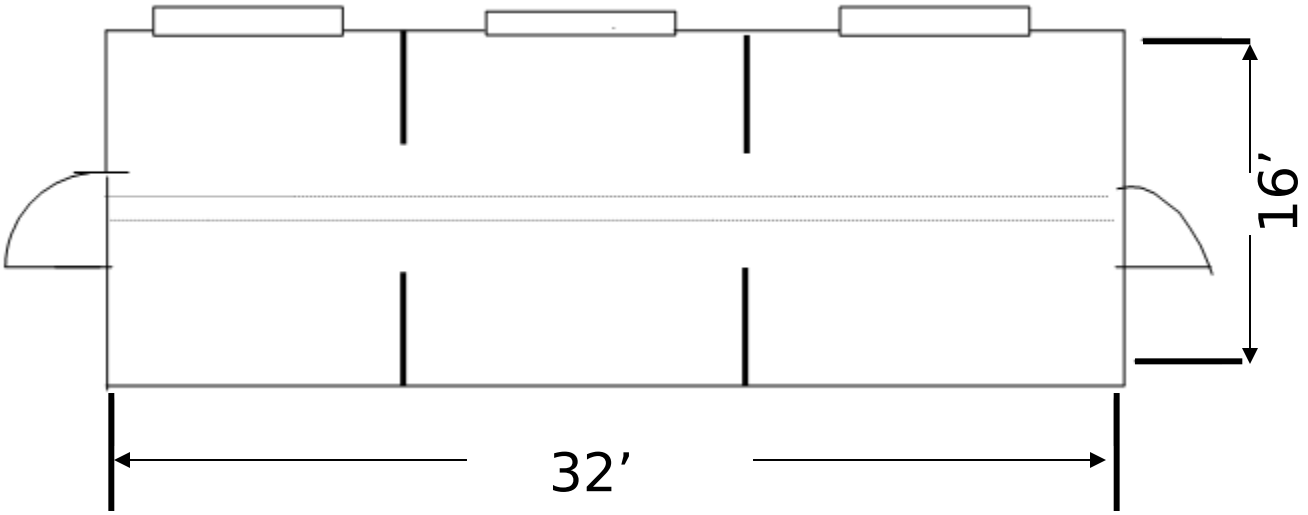
ROW 3



Vertical Construction

Estimate for Bridging

- Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

Estimate for Bridging

- Determine the number of pieces of bridging required:

  number of spaces (between the floor joists)

  x number of rows

  25 spaces

  x 3 rows

  75 pieces of bridging

Vertical Construction

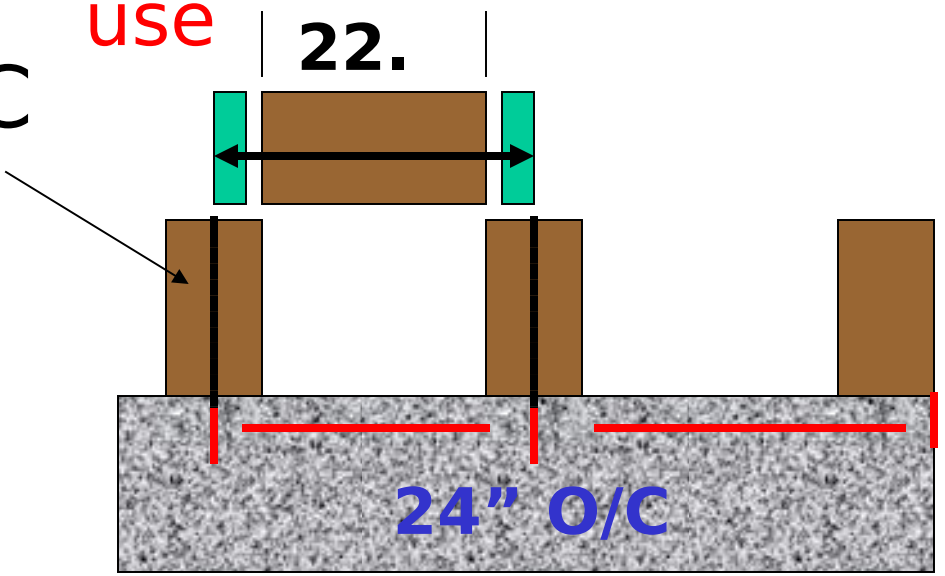
Estimate for Bridging

Step 3: Determine the best EOL for bridging using the on center spacing of the floor joists

You must understand what length of bridging to use

Floor joists 24” O/C

Bridging needs to fit in-between the floor joists



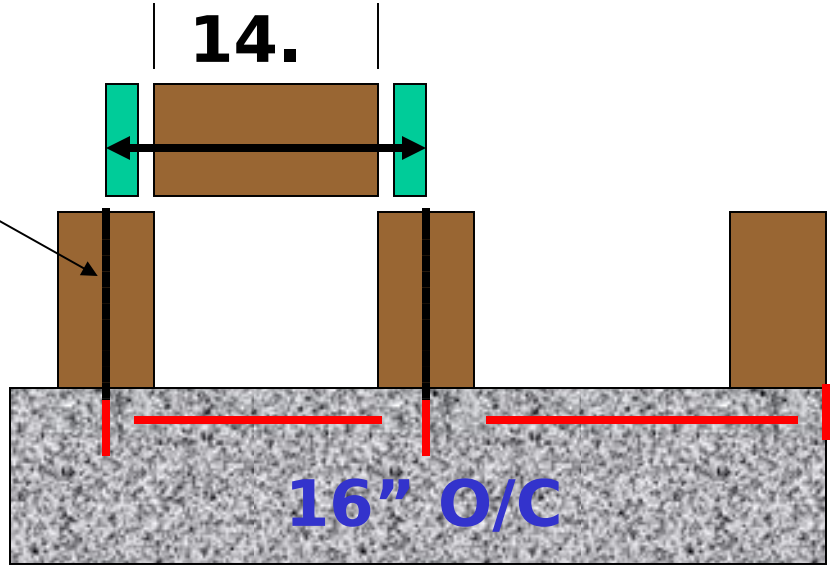
Vertical Construction

Estimate for Bridging

Step 3: Determine the best EOL for bridging compared to floor joist On Center spacing.

Floor joists 16” O/C

Bridging needs to fit in between the floor joists



Vertical Construction

Estimate for Bridging

STEP 1: Determine the best EOL

Convert feet to inches

16’ x 12 =192”

14’ x 12 =168”

12’ x 12 =144”

10’ x 12 =120”

8’ x 12 = 96”

STEP 2: Determine the size of bridging you will need

*O/C Spacing for floor joists is 16” O/C

Vertical Construction

Estimate for Bridging

Step 3: Determine the best EOL by dividing each EOL by the size of bridging

192” / 14.5= 13.24

168” / 14.5=11.58

144” / 14.5=9.93

120” / 14.5=8.27

96” / 14.5=6.62

Use Rule #3: Choose the smallest number after the decimal and round down

13.24 R 13 pcs from one board

Vertical Construction

Estimate for Bridging

Step 4: Determine the total number of boards needed: Divide the total number of pieces [of bridging] by the number of pieces from one board

Number of pieces	EOL		pieces of EOL	waste		Round up
75	13	5.769230769	6	1.1	6.6	7
Calculate Board Foot						
number of pieces	thickn	width	length	constar	bf	
7	2	8	16	12	149.33	

Vertical Construction

Estimate for Sub Floor

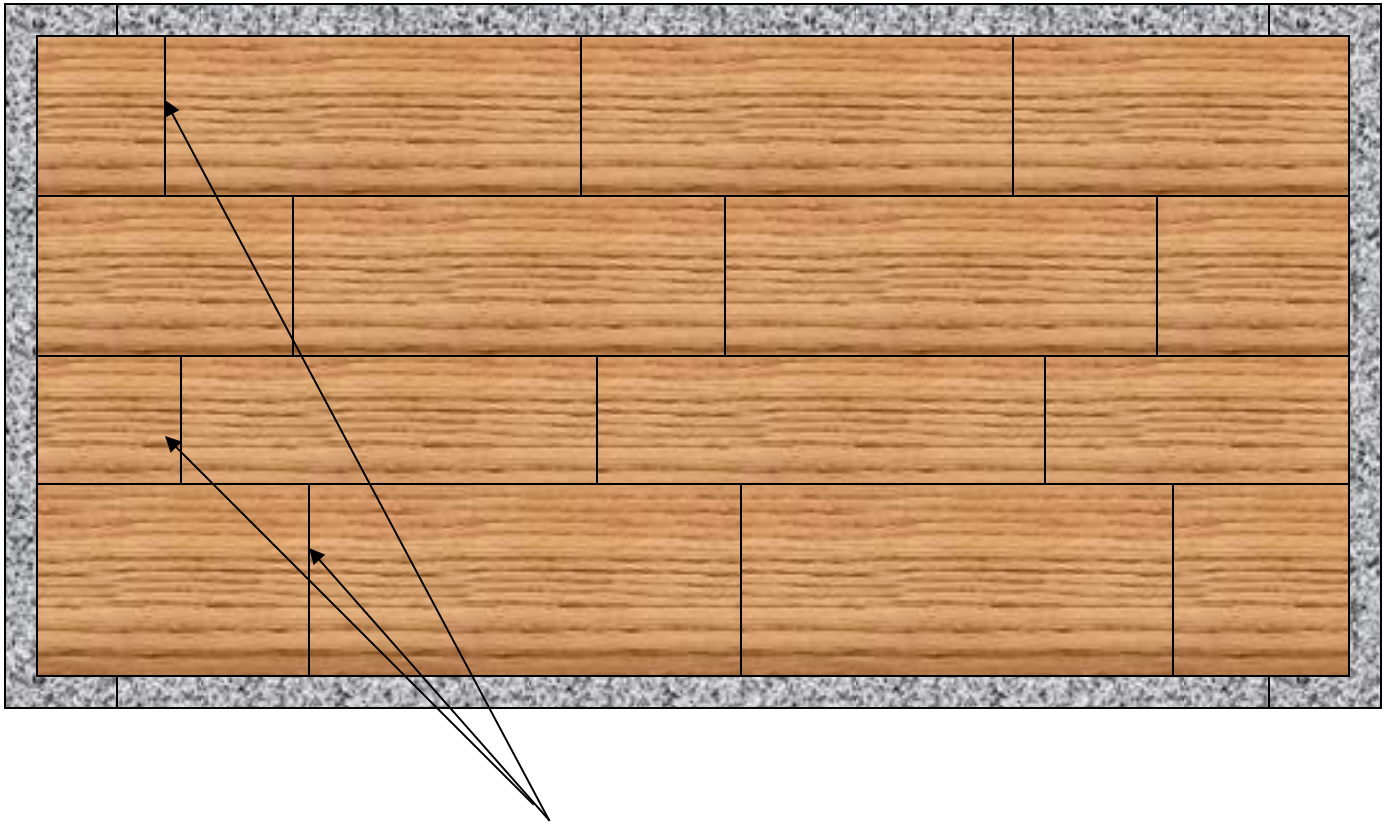
Vertical Construction

Estimate for Sub Floor

- Finish floor and Sub Floor are the same in military construction.
- In most cases in the theater of operation ½ or ¾ plywood is laid directly on the floor joists and nailed with 8d nails

Vertical Construction

Estimate for Sub Floor



Stagger the seams of the plywood

Vertical Construction

Estimate for Sub Floor

Step #1: Determine the total surface area	Bldg length	X	Bldg width	
	32	x	16	512
Step #2: Divide the TSF, step 1 answer, by 32 (32sqft per sheet of plywood)	512	÷	32	16
Step #3: Factor the waste (20% for plywood)	Number of sheets	Waste factor		round up
	16	1.2	19.2	20

Vertical Construction

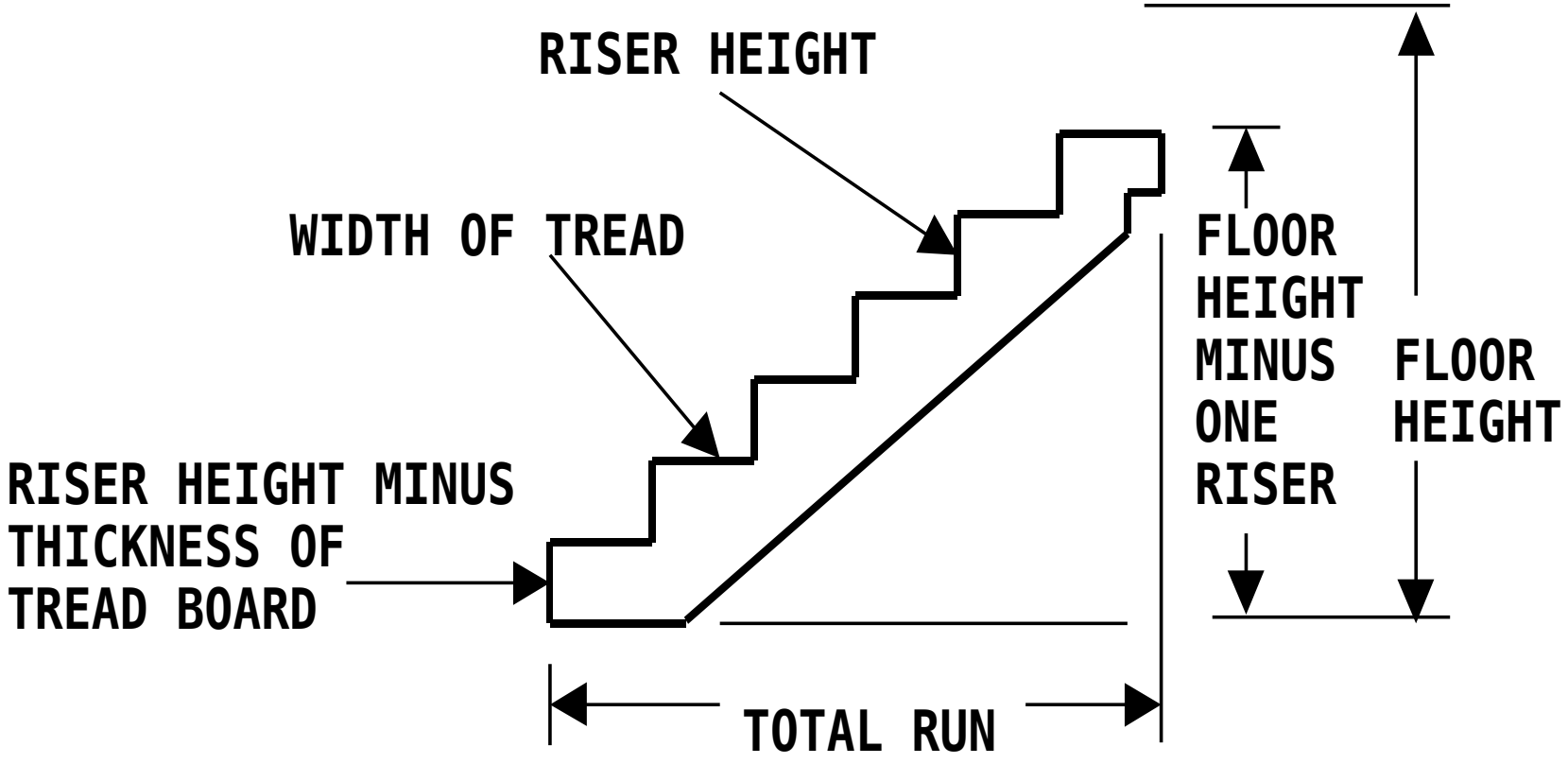
Vertical Construction

Estimate for Stairs

- Stringer – sides that support the weight on stairs, 2” or 3” thick and 8” wide or wider material is used
- Tread – material that forms the horizontal step and distributes the weight to the stringers
- Riser – materials that cover the vertical opening created between the stringers and the treads
- Stair Design – mathematical relationship between riser and tread
- There are usually 3 stringers to a stair if they are more than 36” wide—1 at each of the two outer edges and 1 at the center.

Vertical Construction

Estimate for Stairs



Vertical Construction

Estimate for Stairs

Riser height + tread width = 17 – 19 inches
Riser height x tread width = 70 – 75 inches

If both rules are satisfied then your design is satisfactory

Vertical Construction

Estimate for Stairs

TWO METHODS:

1) STORY POLE – A board with the finished floor height marked on it and a divider set at seven inches. Step off the distance in seven inch increments. If this does not divide evenly, adjust the divider span slightly and step off distance again. Continue adjusting and stepping off until the story pole is marked off evenly. The number of spaces stepped off is the number of risers and the span of the divider is the height of each riser.

Vertical Construction

Estimate for Stairs

2) MATHEMATICAL METHOD - RISERS

-Convert the finished floor height into inches to get the total rise

-Divide the total rise by 7 and round to the next whole number to acquire the number of risers

-Divide the total rise by the number of risers

-Round up or down to the nearest ¼” to acquire the height of each riser

Vertical Construction

Estimate for Stairs

Ex: finish floor height is:	feet	inches	fractional inches	
	6	10	0	
Step #1: convert total rise into inches	feet	inches	fractional inches	total rise
	6	10	0	82.0000
	total rise	number of "ideal" risers	total risers	round up
Step #2: find the number of risers	82.0000	7	11.71428571	12
	total rise	total risers	riser height	
Step #3: Divide total rise by nymber of risers	82.0000	12	6.833333333	
	riser height	fractional inches		
Step #4: round to the nearest 1/4" (up or down)	6.833333333	6 3/4		

Vertical Construction

Estimate for Stairs: Treads

MATHEMATICAL METHOD - TREADS

-Number of treads is acquired by subtracting one from the number of risers

-The width of the treads is determined by the two rules of thumb discussed earlier. Adjustments are made the tread width to ensure the stair design is satisfactory

Vertical Construction

Estimate for Stairs: Treads

ex: Finsh floor height		In feet	In inches	In fractional Inches
		6	10	0
step #1 find the number of treads	Number of risers	subtract 1	#of risers	
	12	1	11	
step #2 check numbers against rules of thumb	Riser height	treat width		
Rule #1: sum is between 17 and 19	6.75	10	sum	
			16.75	
Rule #2: product is between 70 and 75			product	
			67.5	

Vertical Construction

Estimate for Stairs: Treads

ex: Finsh floor height		In feet	In inches	In fractional Inches
		6	10	0
step #1 find the number of treads	Number of risers	subtract 1	#of risers	
	12	1	11	
step #2 check numbers against rules of thumb	Riser height	treat width		
Rule #1: sum is between 17 and 19	6.75	10	sum	
			16.75	
Rule #2: product is between 70 and 75			product	
			67.5	
STEP 3: Adjust tread width and plug into rules of thumb again				
	Riser height	treat width		
Rule #1: sum is between 17 and 19	6.75	10.5	sum	
			17.25	
Rule #2: product is between 70 and 75			product	
			70.875	

Vertical Construction

Estimate for Stairs: Treads

Step #4 Calculate the total run			
	# of treads	tread width	total run
	11	10.5	115.5
Step #5: Convert the run, in inches, into feet	Run, in inches	divide by 12	
	115.5	9.625	
		9	
	minus the whole number	0.625	
		x12	
		7.5	
	minus the whole number	7	
		0.5	
		x16	
	answer in 16ths	8	
	answer =	9' 7 8/16"	
		9' 7 1/2"	

Vertical Construction

Estimate for Stairs: Summary

Finished floor height 82”

12 risers at 6 ¾” height

11 treads at 10 ½” width

Total run 115.5” or 9’ 71/2”

Vertical Construction

Estimate for Stairs: Est. material for stringer

DETERMINE STRINGER MATERIAL USING PYTHAGOREAN THEOREM

$$A^2 + B^2 = C^2$$

(FLOOR HT X FLOOR HT) + (TOTAL RUN X TOTAL RUN) = C^2

Step #1 Find C^2	a = rise	b = run	c = stringer length
	82	115	?
Step #2: Add the rise (squared) to the run (squared)	a^2 =	b^2 =	c^2 =
	6724	13225	19949
Step #3: Find the square root of	19949		
answer	141.2409	inches	

Vertical Construction

Estimate for Stairs: Est. material for stringer

Convert the run, in inches, into feet	Run, in inches	divide by 12
	141.64	11.8033333
		11
	minus the whole number	0.80333333
		x12
		9.64
	minus the whole number	9
		0.64
		x16
	answer in 16ths	10.24
	answer =	11' 9 10/16"
		11' 9 5/8"

Vertical Construction

Estimate for Stairs: Est. material for Stringers

EOL IS DETERMINED BY THE ANSWER FOR C - THE STRINGER LENGTH. SINCE THE STRINGER LENGTH IS 11' 9 10/16" | 11' 9 5/8" THEN THE EOL IS 2” x 10” x 12’.

There are two set of stairs for this building.

STEP 1: 2 stringers per stairs x 2 sets) = 4 stringers

STEP 2: ADD 10% WASTE

4 X 1.1 = 4.4 R 5 PCS

Vertical Construction

Estimate for Stairs: Est. material for stringer

STEP 3: Convert to board feet

(Quantity x width x thickness x length) ÷ 12

(Qty 5 x wt 2 x tk 10 x lgt12) ÷ 12 = 100 b

Qty	Thickness	Width	length	constant (1	board feet
5	2	10	12	12	100

Vertical Construction

Estimate for Stairs: Est. material for 3 feet wide

Stairs are straight

EOL determined is 2” x 4” x 12’ since the tread will be 3 – 2 x 4 side by side

(treads can be one piece or multiple pieces)

Step 1: 3 pcs/tread x 11 treads = 33 x 2 sets = 66 pcs 2 ” x 4” x 3’

Step 2: 66 ÷ 4 pcs (3’ long) per EOL = 16.5 or 17 pcs of 12’

Vertical Construction

Estimate for Stairs: Est. material for stringer

Step 3: Add 10% waste:

17 x 1.1 = 18.7 or 19 pcs

Step 4: Convert to board feet:

Step #1 Calculate the number of pieces required:	pieces per tread	number of treads	number of sets of stairs	#of pieces		
	3	11	2	66	2" x 4" x 3'	
Step #2: Pieces of EOL required:	#of pieces	#of pieces per EOL		round up if required		
	66	4	16.5	17		
	#of total pieces of EOL	X Waste				
Step #3 calculate using the waste factor:	17	1.1	18.7	19		
Calculate Board Feet	Qty	thickness	width	length	constant (12)	board feet
	19	2	4	12	12	152

Vertical Construction

Vertical Construction

Wall frames

Sole plate

The bottoms of all partition walls and outside walls laid horizontally on the floor

Top plate

The top plate ties the studding together at the top

The top plate serves as a connecting link between the wall and roof. The top plate may be double or single

Vertical Construction

Wall frames

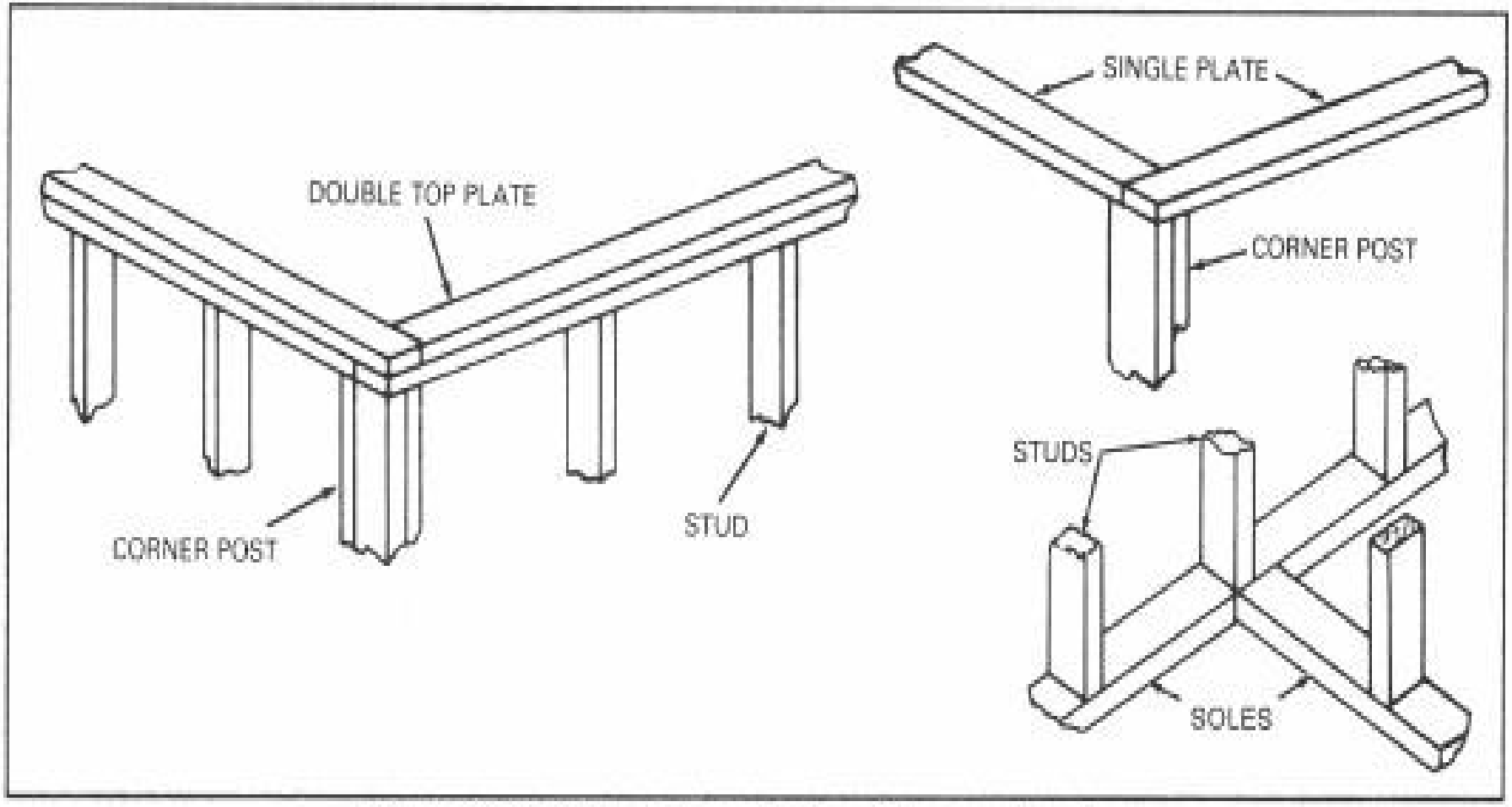
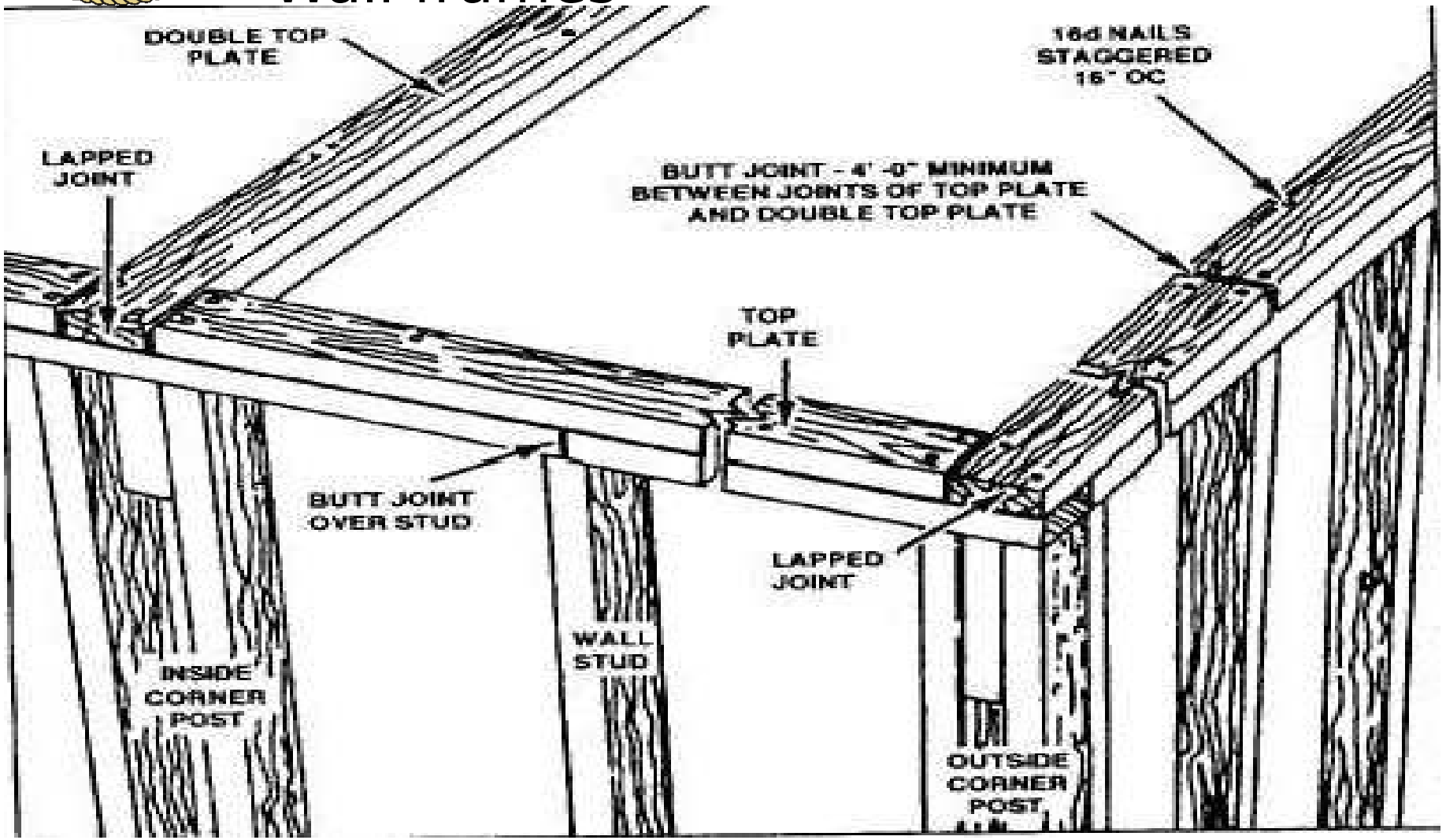


Figure 6-36. Top-plate and sole-plate construction

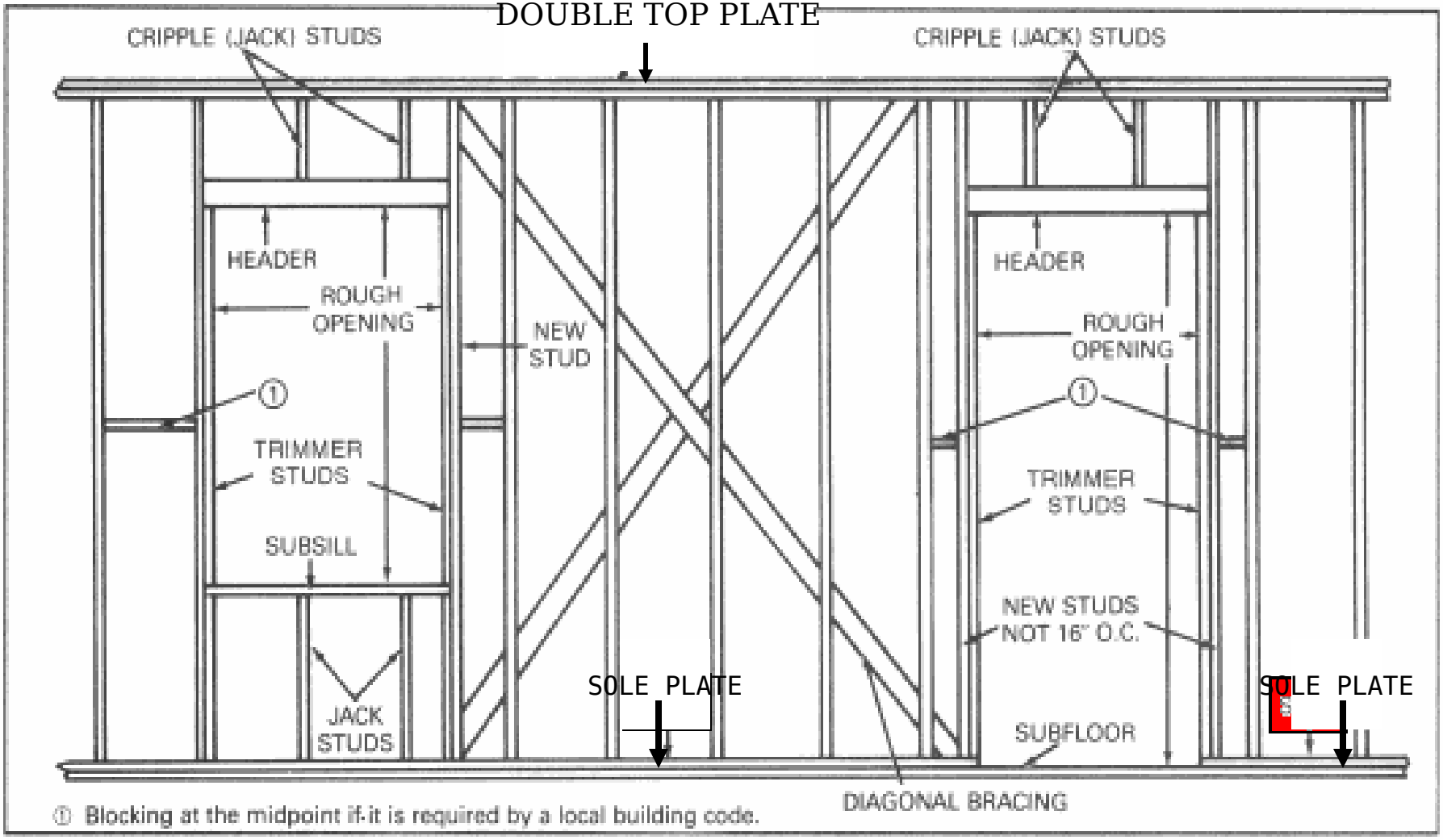
Vertical Construction

Wall frames



Vertical Construction

Wall frames



Vertical Construction

Wall frames

Wall Studs.

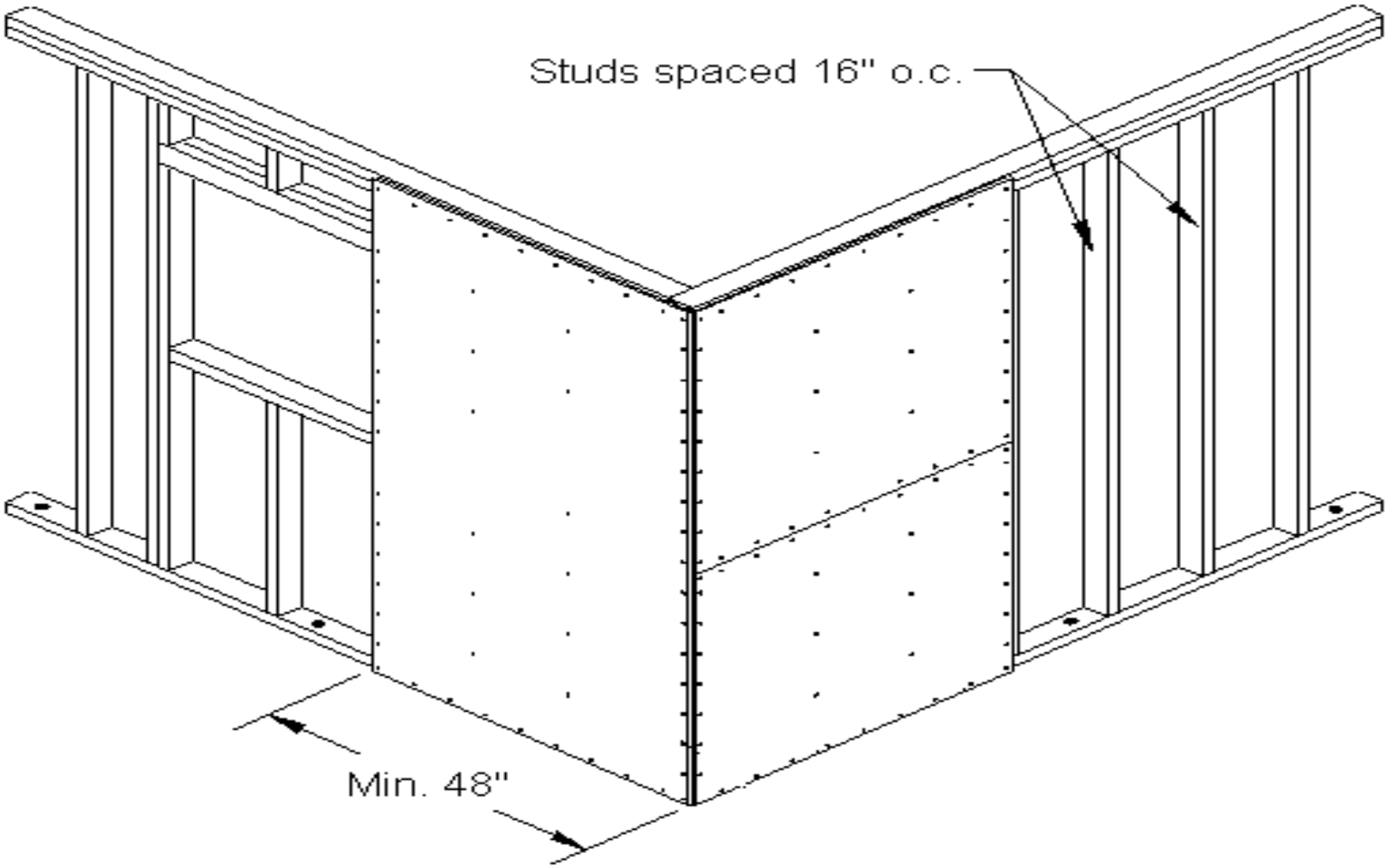
The purpose is to support the weight of the upper framework and interior and exterior finishes. Studs are normally spaced 16, or 24 O/C center.

Corner/T Posts.

Studs used at the corners or partition of frame construction are usually built up from three or more ordinary studs to provide greater strength.

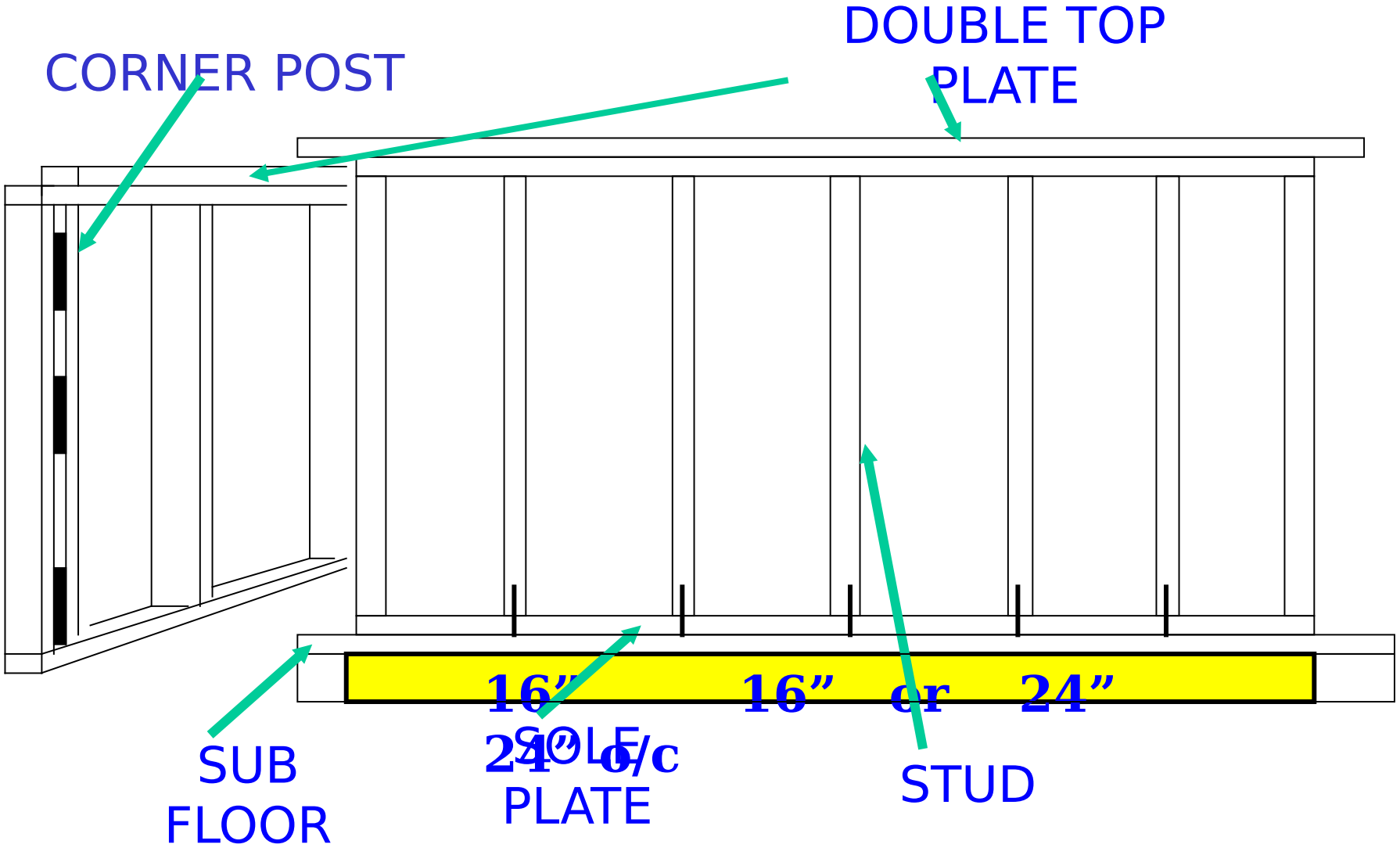
Vertical Construction

Wall frames



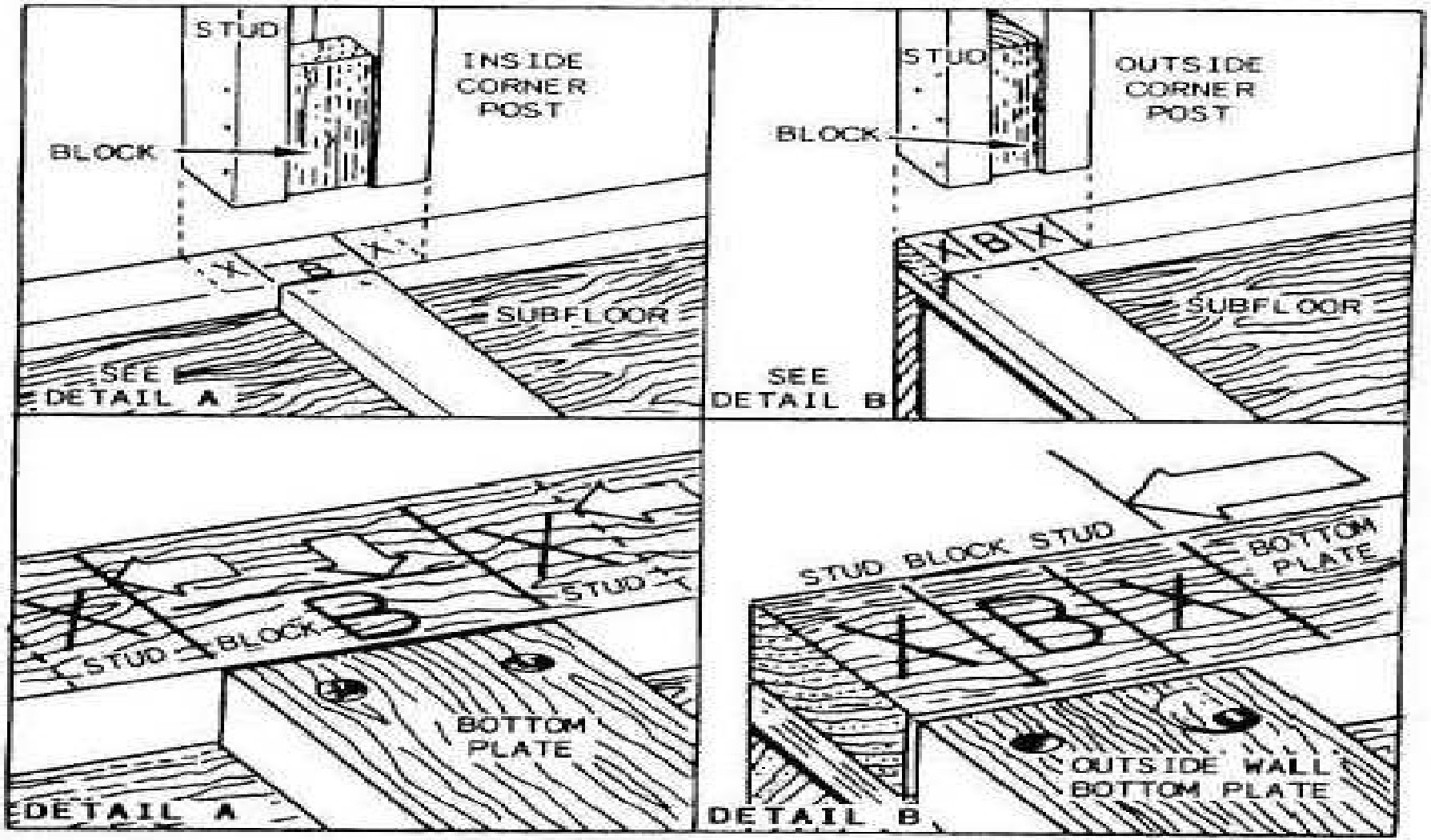
Vertical Construction

Wall frames



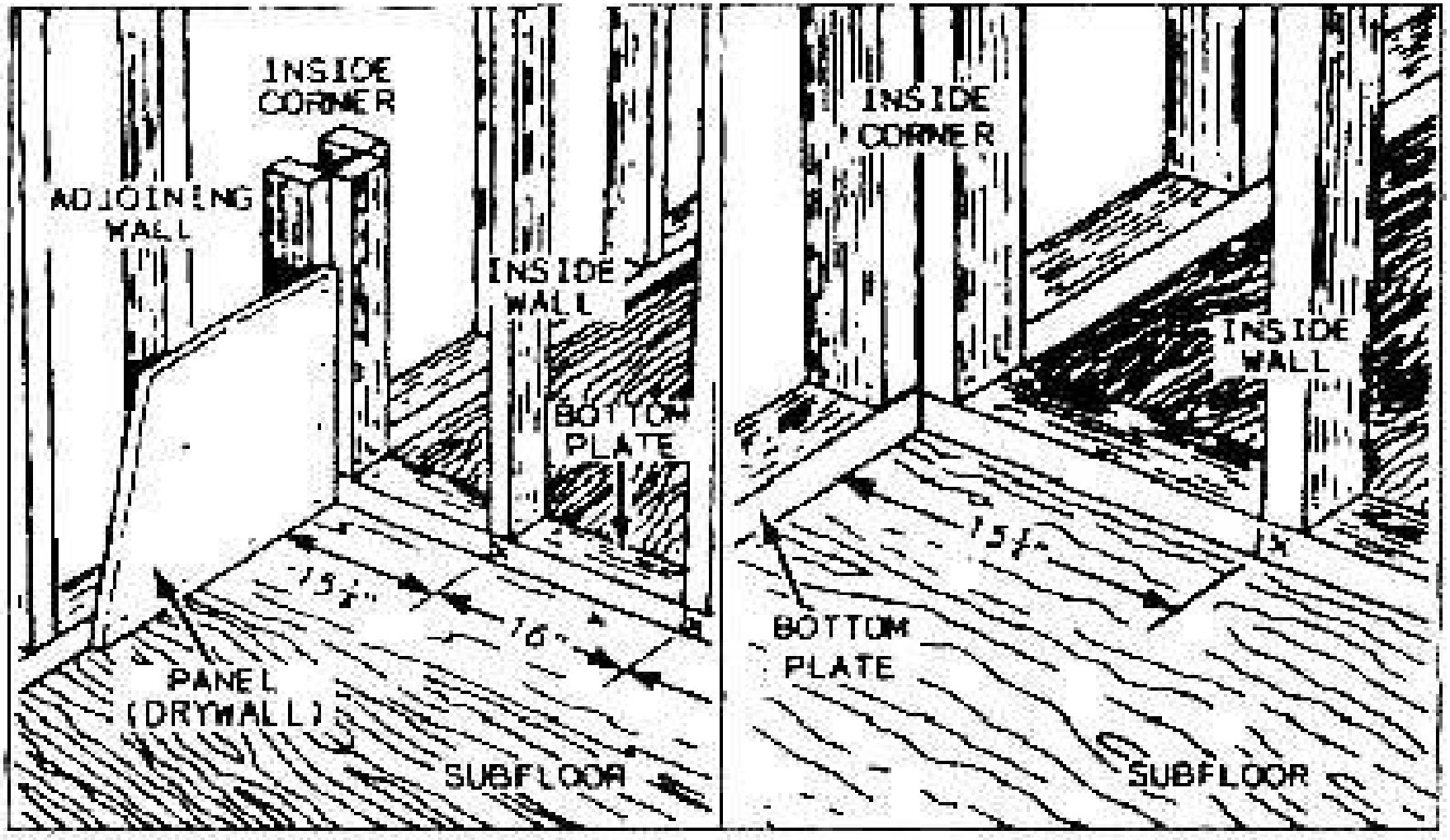
Vertical Construction

Wall frames



Vertical Construction

Wall frames



Vertical Construction

Wall frame Openings

WALL FRAME OPENINGS

-Trimmer Studs

-Headers – above doors and windows

-Sub sill – under window

-Cripple Studs – above header or below sub sill

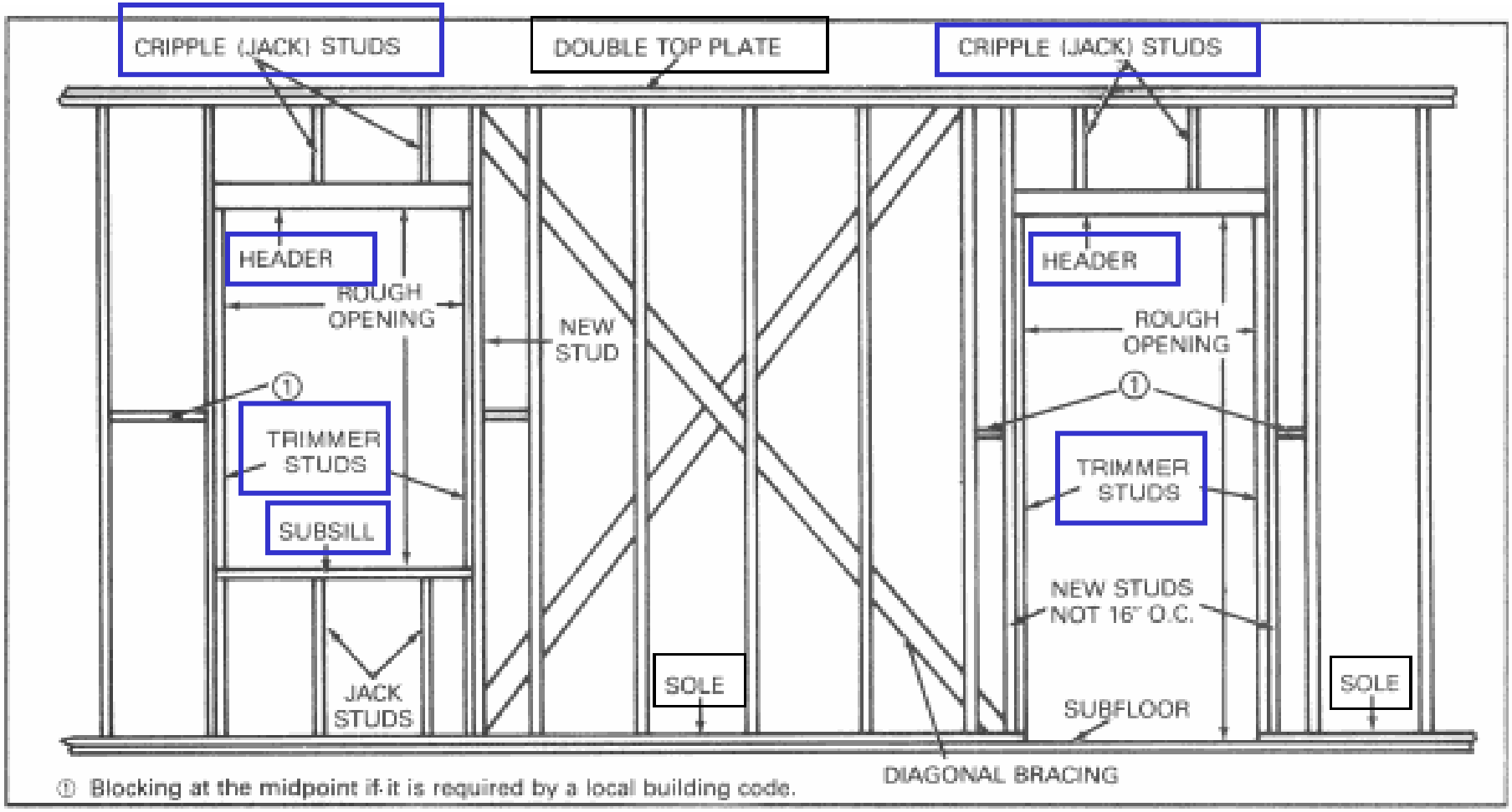
Rough openings:

-door openings 2 ½” larger than actual door

-window openings will vary according to style used

Vertical Construction

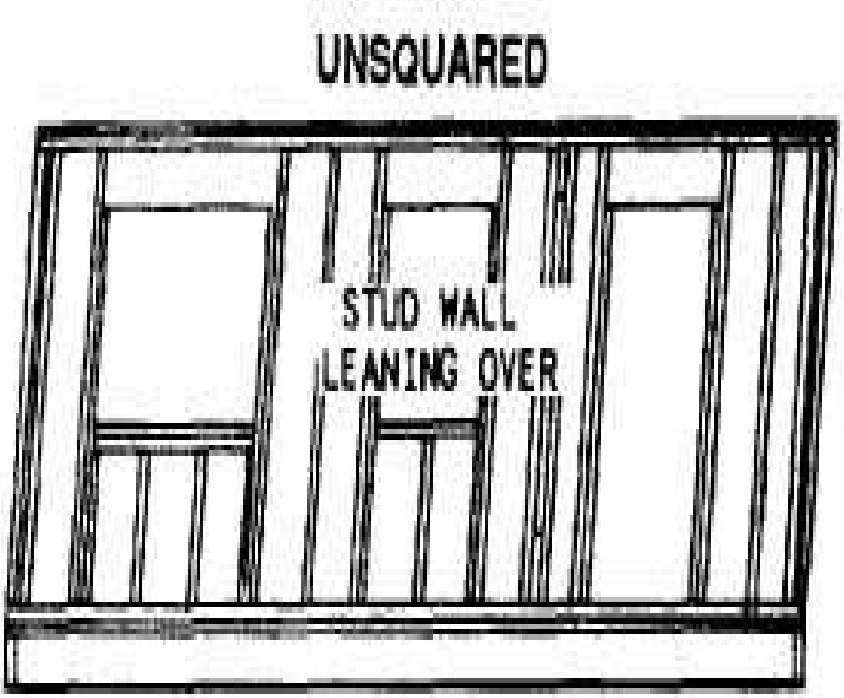
Wall frames

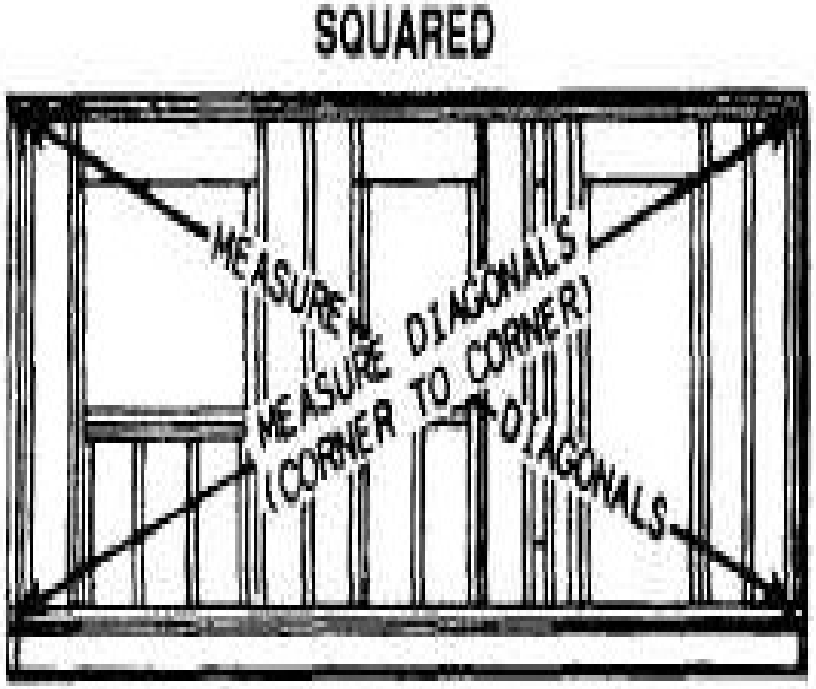


Vertical Construction

Wall frames: plumbing and straightening

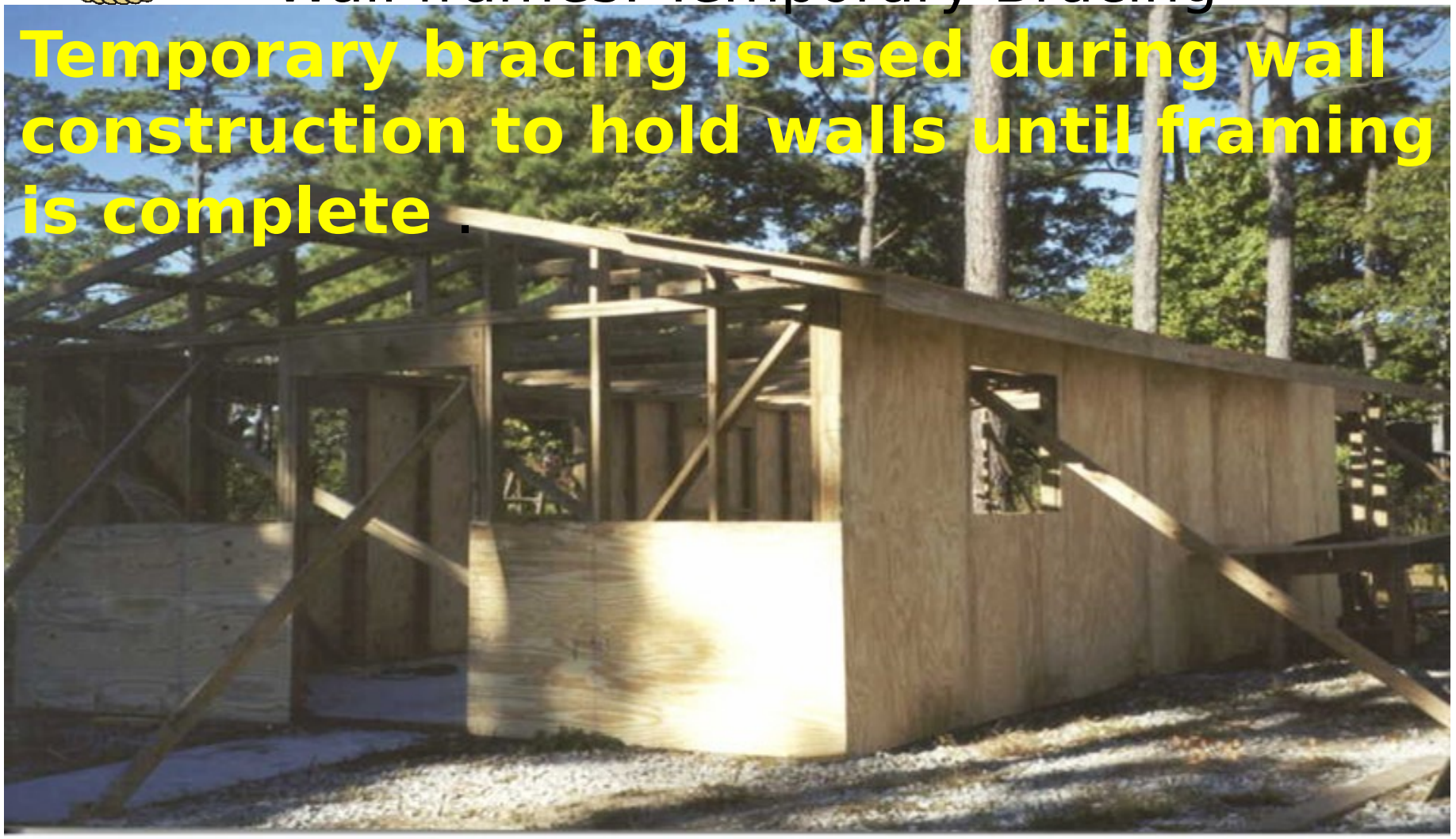
Walls MUST be plumb and straight so that the permanent braces and rafters may be installed.





Vertical Construction

Wall frames: Temporary Bracing



Vertical Construction

Wall frames: Permanent Bracing

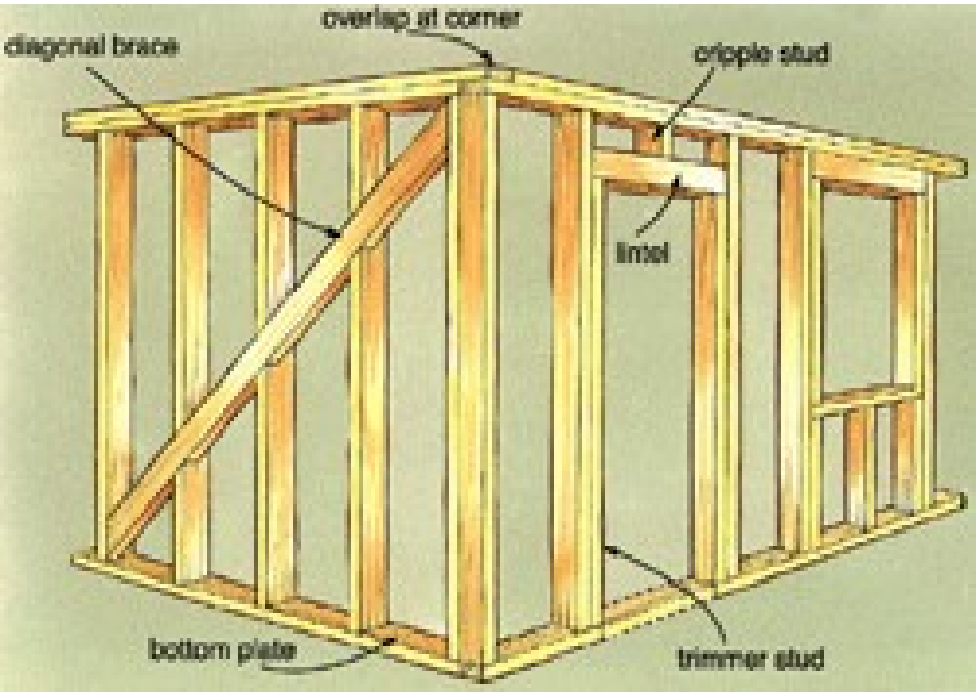
- Bracing is used to stiffen framed construction and make it rigid.

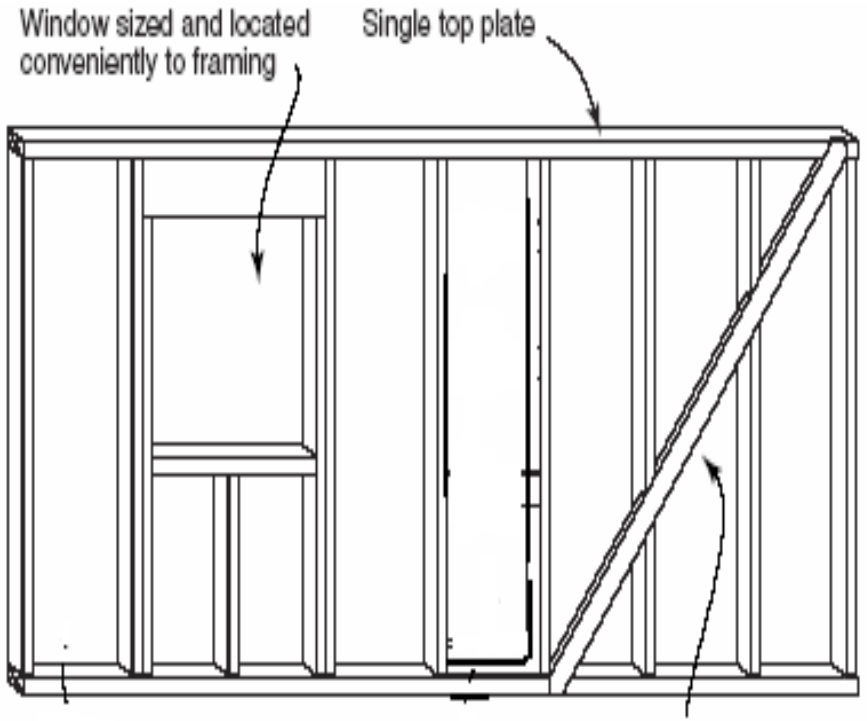
- There are three methods commonly used to brace frame structures:
  - Let-in bracing
  - Cut in bracing
  - Diagonal Sheathing

Vertical Construction

Wall frames: Let-In Bracing

Bracing set into the edges of studs, flush with the surface. The studs are always cut to let in the braces; the braces are never cut. 1" x 4" or 1" x 6"





Vertical Construction

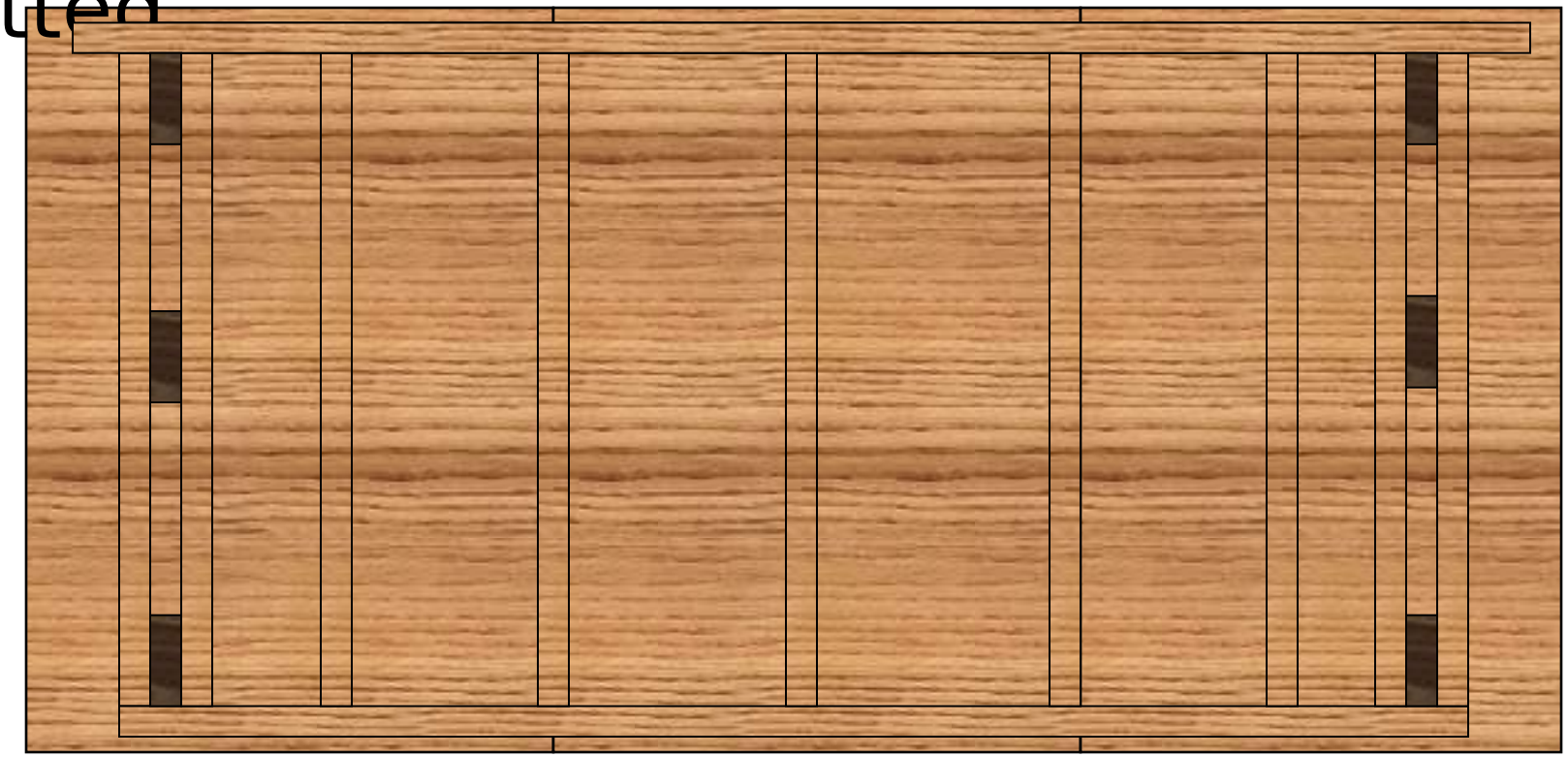
Wall frames: Cut-In Bracing

It is cut at an angle to permit toe nailing between the studs and is inserted in diagonally

Vertical Construction

Wall frames: Diagonal Sheathing

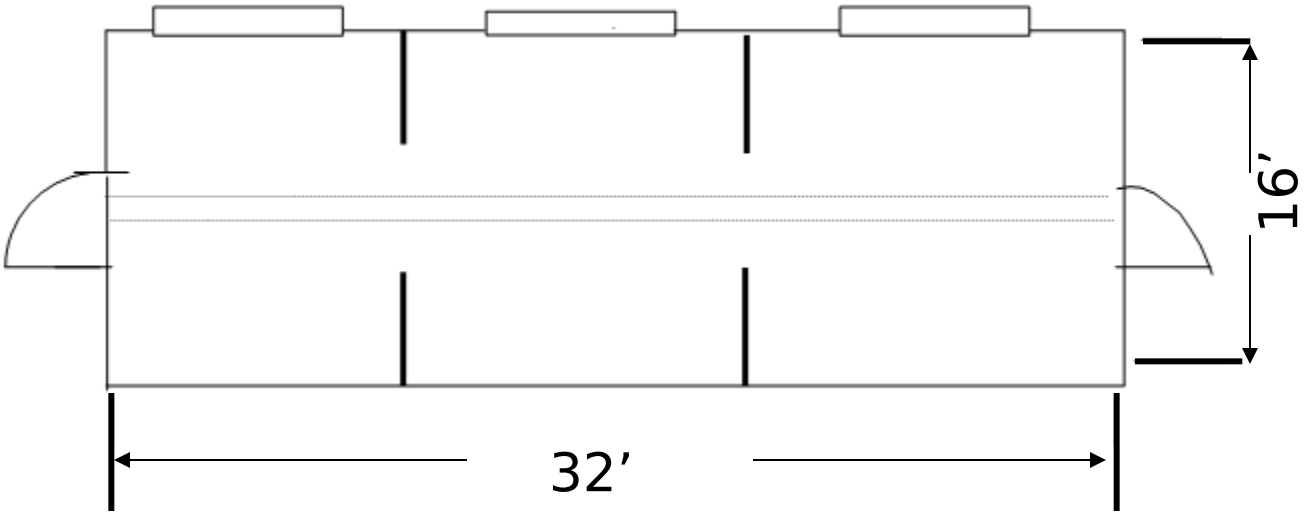
Strongest type of bracing. If 3/8 inch thick or more is used, other methods of bracing may be omitted



Vertical Construction

Wall frames: estimate material for plates

- Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

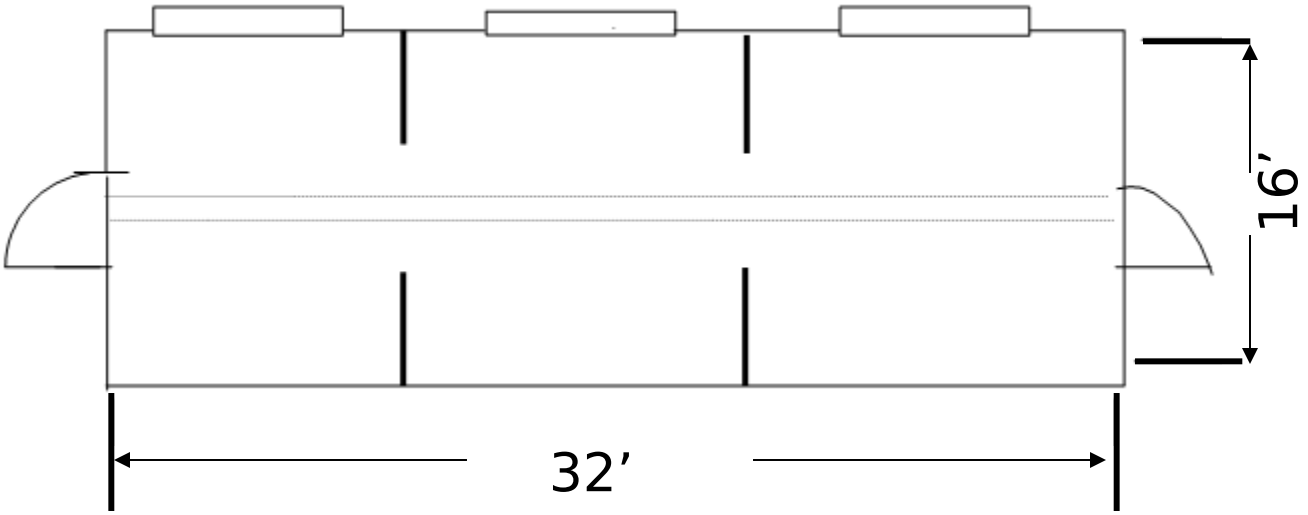
Estimate material for sole and top plates

Step #1: Determine the perimeter of the building						
	Bldg length	Building width	number of sides	perimeter =		
	32	16	2	96		
Step #2: add all partitions	number of partitions:	Building width	perimeter =	total linear feet		
	2	16	96	128		
Step #3: Multiply TLF by number of sole plates + top plates	sole plate	top plate	double top plate	total plates	TLF	total plates
	1	1	1	3	128	384
Step #4: determine best EOL Rule #2	EOL (in feet)	total #of plates	pieces of EOL			
	16	384	24			
	14		27.42857143			
	12		32			
	10		38.4			
	8		48			
Step #5 factor in your waste	Pieces of EOL	waste factor	round up if required			
	24	1.1	26.4	27		
Step #6 Calculate board feet	qty	thickness	width	length	constant	board feet
	27	2	4	16	12	288

Vertical Construction

Wall frames: estimate material for plates

- Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

The total linear feet was determined in the previous problem

Step 1: Determine total linear feet of building

(50’ + 20’) x 2 = **140 LnFt (exterior walls)**

(20 x 2)= **40 LnFt (partitions)**

140 LnFt + 40 LnFt = 180 Total LnFt

Step 2: Divide the TLF by the On Center spacing (make sure you use like measurements) round UP if necessary.

180 LF ÷ 1.33’ STUD SPACING

= 135.33 OR 136

Vertical Construction

Step 1: Determine total linear feet of building. The total linear feet was determined in the previous problem:

Step 2: Divide the TLF by the On Center spacing (make sure you use like measurements) round UP if necessary.

Step #1: Determine the total linear feet of the building.	Building length	Building Width	TLF (ext. walls)	Partitions	TLF of Building
	32	16	96	2	128
Step #2: Divide TLF by O/C spacing	TLF of building	O/C Stud spacing (in feet)			
	128	1.33	96.240602	97	

Vertical Construction

Additional studs:

- **If interior finish is <u>not</u> required add <u>one</u> additional stud per corner**
- **If interior finish is required, add <u>two</u> additional studs per corner for corner post and T-post**
- **Add one additional stud per opening (windows and doors)**

Vertical Construction

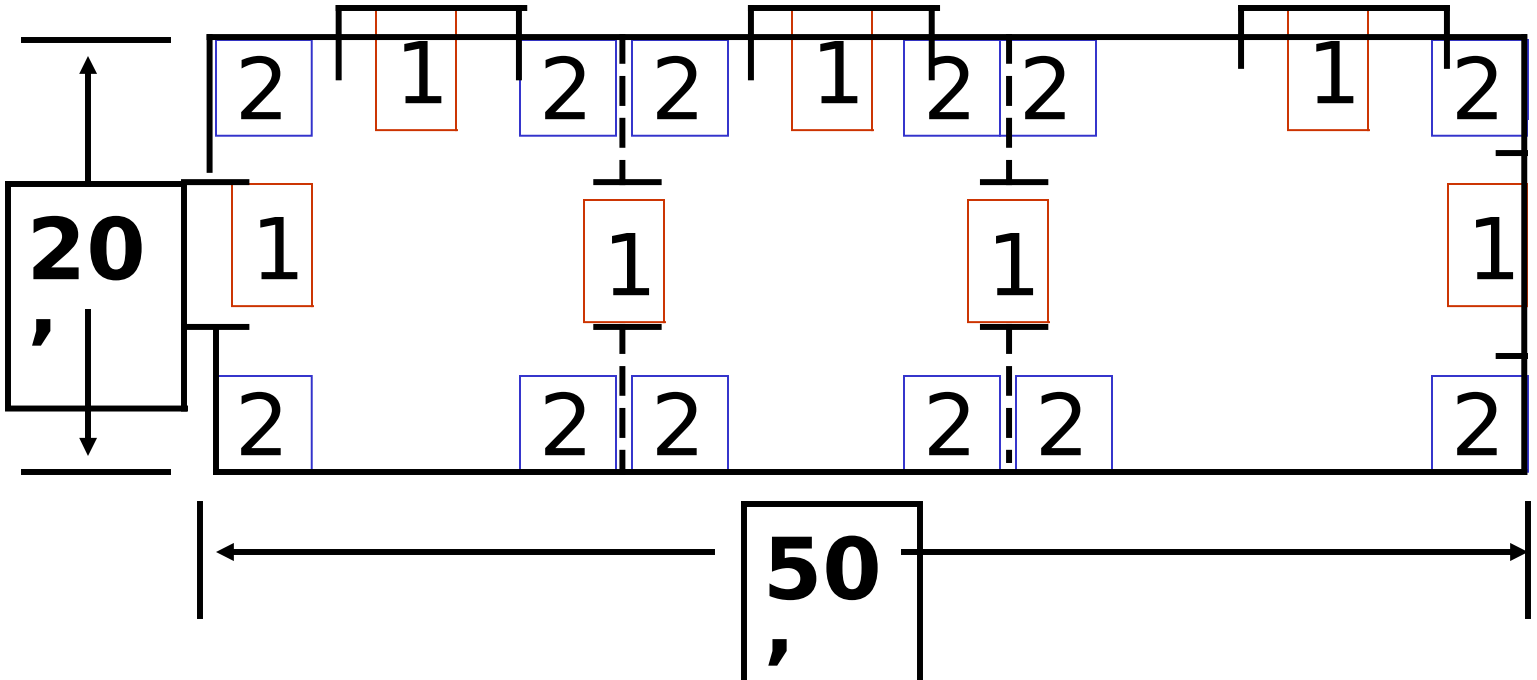
STEP 3:

Add 2 studs per corner

24 corner studs

Add 1 stud per opening.

Total studs for openings



Vertical Construction

Step 4: Add all studs together

wall studs + corner studs + openings = total studs for building

Step 5: Determine the best EOL. Rule 1 Standard wall height is 8'. Predetermined

Step 6: Add 10% waste factor (round up)

Step 7: Convert to board feet

Vertical Construction

Step #4: Add all studs together	wall studs	(+) corner studs	(+) openings	Total studs for building		
	97	24	7	128		
Step #5: Determine Best EOL Rule #1	Wall Height (in feet)					
	8					
Step #6: Add waste factor	Total studs for building	waste factor	round up as necessary	total adjusted studs for building		
	128	1.1	140.8	141		
Step #7: calculate board feet	qty	thickness	width	length	constant	board feet
	141	2	4	8	12	752

Vertical Construction

Estimate material for wall studs: expedient method

Step 1: Determine Total Linear Feet

(Bldg Lgt + Bldg width) x 2 =

+ Partitions

TLF

Step #1: Determine the total linear feet of the building.	Building length	Building Width	TLF (ext. walls)	Partitions	TLF of Building
	32	16	96	2	128

Vertical Construction

Estimate material for wall studs: expedient method

Step 2: Determine the O/C spacing

Step 3: Divide TLF by the O/C spacing

Step 4: Convert to Board Feet

Total studs needed include extra for corners, extra for door and window openings and waste factor.

Vertical Construction

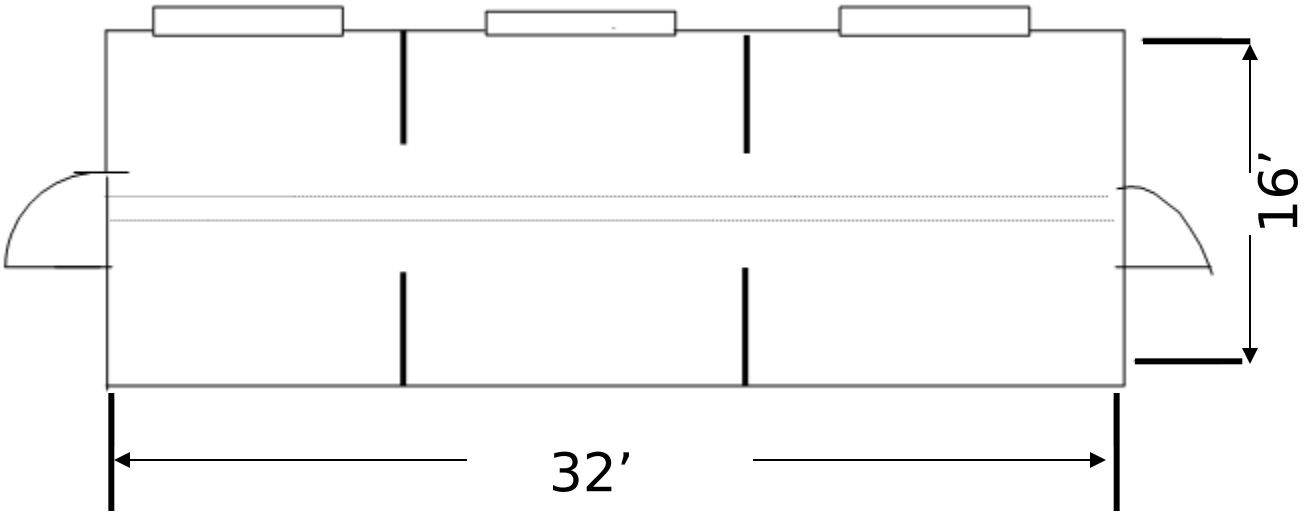
Estimate material for wall studs: expedient method

Step #2: determine O/C spacing	16" O/C	24" O/C				
	1	1.33				
Step #3: multiply number of studs by O/C spacing	Number of studs	O/C spacing	total studs for building			
	128	1	128			
Step #4: Convert to board feet	qty	thickness	width	length	constant	board feet
	128	2	4	8	12	682.6666667

Vertical Construction

Wall frames: estimate material for plates

- Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

Estimate material for exterior sheathing

Step 1: Determine Sq footage of outside walls

Building length multiplied by the wall height (Standard wall height is 8').

50 x 8 ht = 400 SQFT ONE SIDE

Building width multiplied by wall height

20 x 8 ht = 160 SQFT ONE SIDE

Then multiply that answer by two. This will give the total square feet.

(400 + 160) x 2 = 1120 SQFT TOTAL

Vertical Construction

Estimate material for exterior sheathing

Step 1: Determine Sq footage of outside walls

(Building length x wall height) (Standard wall height is 8')

\+ (Building width x wall height)

answer x 2 = total square feet

Step 2: Divide the total ft^2 by the ft^2 in one sheet of plywood (4’ x 8’ = 32 $ft^{2)}$ DO NOT ROUND UP!

Step 3: Factor the waste by multiplying the answer from step 2 by 1.2

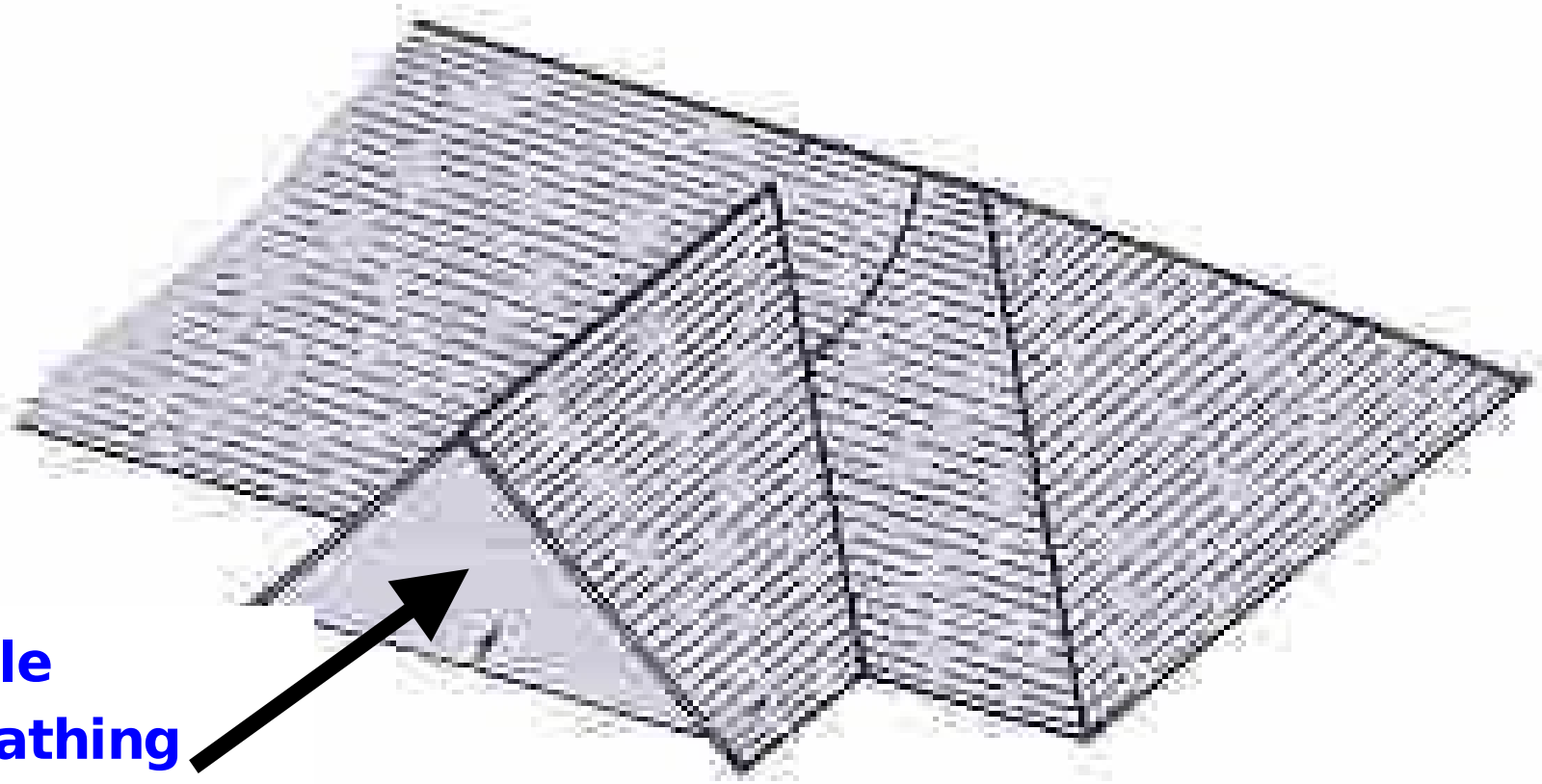
Vertical Construction

Step 1: determine the ft^2 of outside walls	Building length	building width	wall height	number of sides	square foot of outside walls =
	32	16	8	2	768
Step 2: Divide by the ft^2 in a sheet of plywood	square foot of outside walls =	ft^2 in (1) 4'x8' sheet of plywood	number of sheets		
	768	32	24		
Step #3: calculate the waste	number of sheets	waste factor for plywood		total sheets of plywood	
	24	1.2	28.8	29	

Vertical Construction

Vertical Construction

Material Estimations: Gable End Sheathing



Vertical Construction

Material Estimations: Gable End Sheathing

The following are key gable end sheathing and roofing terms:

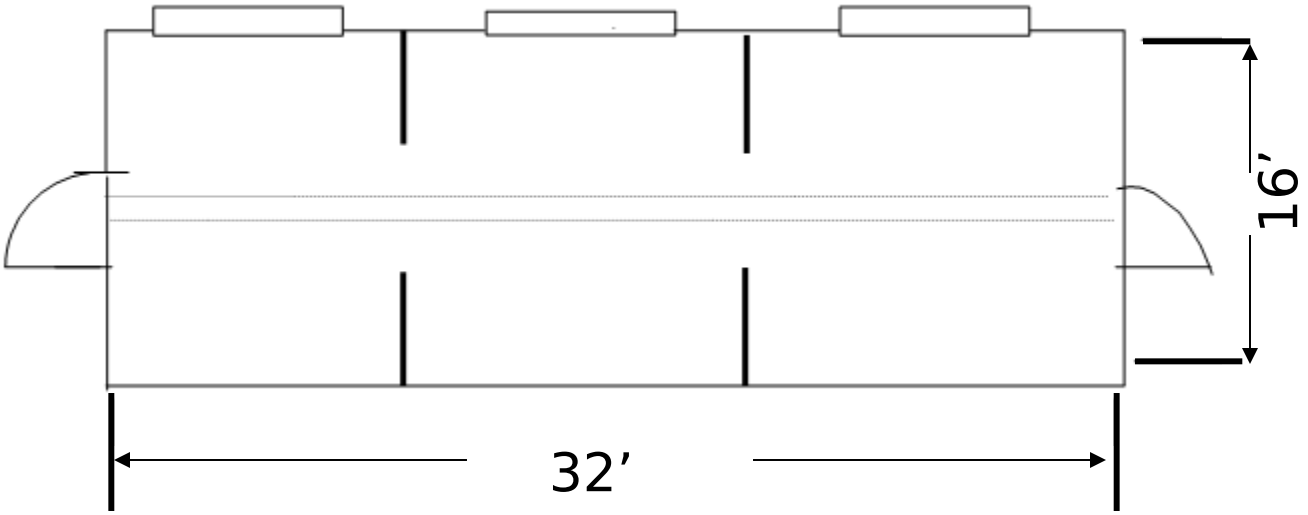
The "RUN" is 1/2 the width of the building to be covered

- The "PITCH" is the slope of the roof determined by the prints.
- The "CONSTANT #" is the size of the material used for the rafter. For 2" x 4" material, the constant is 4; for 2" x 6" material, the constant is 6.

Vertical Construction

Wall frames: estimate material for plates

- Situation: You are given a building with the following dimensions of 32 feet long and 16 feet wide. The following sketch and information is provided.



Vertical Construction

Material Estimations: Gable End Sheathing

Step 1: Determine the square footage of the gable end of the building with 4/12 pitch and 2" x 4" material

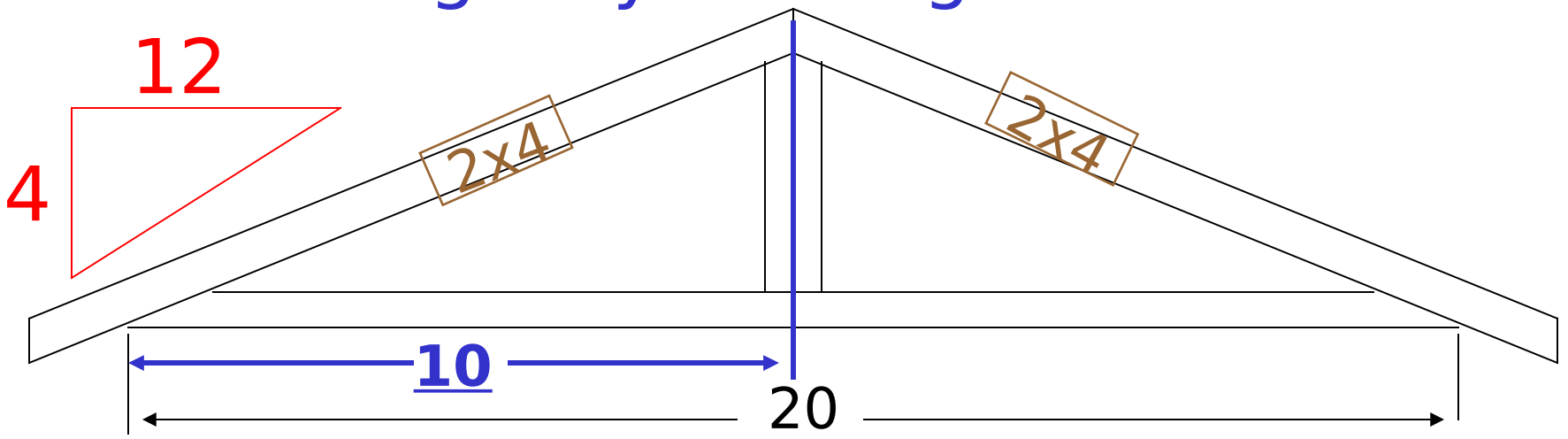
(Run x the rise of the Pitch) + constant for ra
material = gable rise in inches

Vertical Construction

Material Estimations: Gable End Sheathing

Run (equals 1/2 bldg width)		x Rise of the pitch		(+) constant for rafter material	gable rise (in inches)
building width	x 1/2	rise	run	if using 2" x 4" material = 4	
20	0.5	4	12	if using 2" x 6" material = 6	
10		4		4	44

This will give you the gable rise in inches.



Vertical Construction

Material Estimations: Gable End Sheathing

STEP 2 Convert to ft ÷ By 12 = Gable rise in ft

Gable rise in Inches **44 inches ÷ 12 = 3.6**

STEP 3: Take the Total Rise in Feet x the Total width of Bldg = Square Foot of 1 Gable end **3.66 feet x 20 = 73.2**

STEP 4: Square Foot of 1 Gable end ÷ by 32 to = number of Sheets 73.2 ÷ 32 = 2.28

STEP 5: Add Waste 2.28 x 1.2 = 2.73 don't

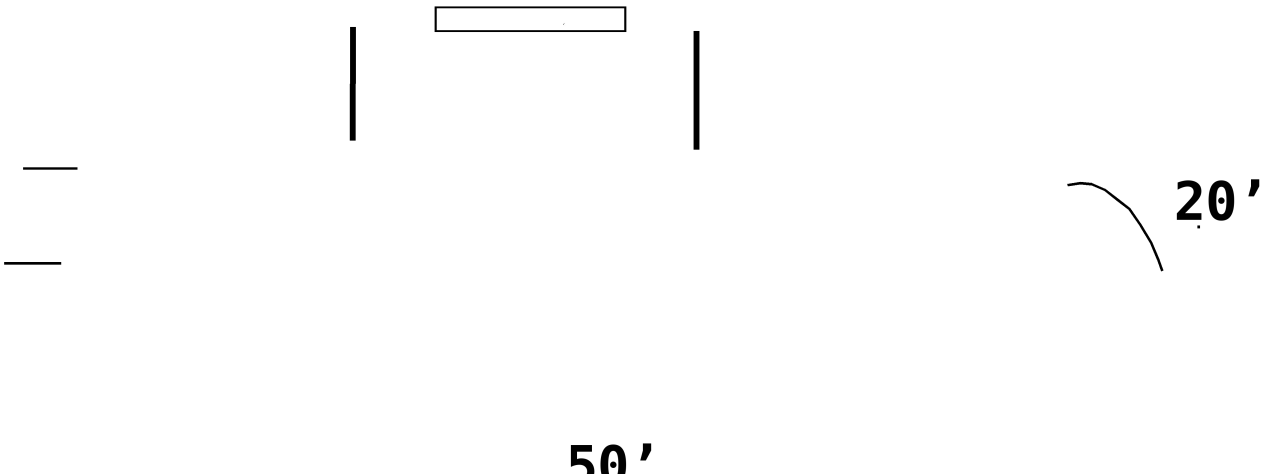
STEP 6: number of Sheets x # of sides

2.73 x 2 = 5.46 or 6 Sheet of

Vertical Construction

Material Estimations: Interior Walls and Sheathing

Situation: You are given a building with the following dimensions of 20 feet wide and 50 feet long. The following sketch and information is provided.



Vertical Construction

Material Estimations: Interior Walls and Sheathing

STEP 1: Determine the TLF of the perimeter:

(L[ength] + W[idth]) x 2 = TLF

(50+20)x2 = 140

Vertical Construction

Material Estimations: Interior Walls and Sheathing

<u>STEP 2</u>: Determine the total sqft for interior walls

Add in the double length of the partition walls (sheathing both sides)

(20 + 20) x 2 = 80

Multiply by the height of the wall

(140 + 80) x 8 = 220 x 8 = 1760

Vertical Construction

Material Estimations: Interior Walls and Sheathing

STEP 3: Determine the sheets of sheathing

Divide this by 32 as there are 32 sqft in a single sheet of plywood/drywall

1760 / 32 = 55 sheets

Vertical Construction

Material Estimations: Interior Walls and Sheathing

Step 2: Determine the total sqft for the ceiling:

50 x 20 =1000 ÷ 32 = 31.25 sh for ceiling

Step 3: Add the sheets from the walls, previous calculation, to the sheets for the ceiling:

From walls: 55 sh + ceiling = 31.25 = 86.25

Vertical Construction

Material Estimations: Sheet rock nails

Sheet rock n[illegible] are calculat[illegible] the rate of 2 pound per every 100 squ[illegible]eet

TSF of the walls + TSF of th[illegible]ing

1760(walls) + 1000([illegible]ing) = 2760 SQFT

TSF ÷ 100 = LBS OF NAILS

2760 ÷ 100 = [illegible]6 LBS x 1.5 = 41.4

Add 10% waste = 41.4 X 1.1= 45.54

OR 46 lbs of sheet rock nails

Vertical Construction

Material Estimations: Sheet rock nails

Using the me[illegible]od detailed in [illegible]5-426,
For flooring, sheathing, and o[illegible]L”
material, use the following:

$$\frac{\text{Nail size (2-8d) x [illegible]ard [foot] measure}}{4 \times 100}$$

8d x 2760 = 22080

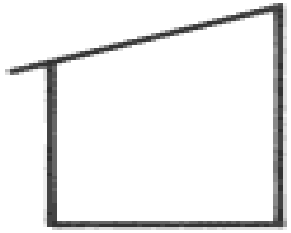
22080 / 400 = 55.2

Vertical Construction

Vertical Construction

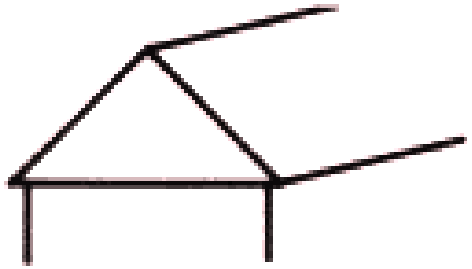
Vertical Construction

LEAN-TO OR SHED ROOF. This roof is used where hasty or temporary construction is needed and where sheds or additions to buildings are erected. The pitch of this roof is in one direction only. The roof is held up by the walls or posts on four sides. One wall, or the posts on one side, is higher than those on the opposite side.



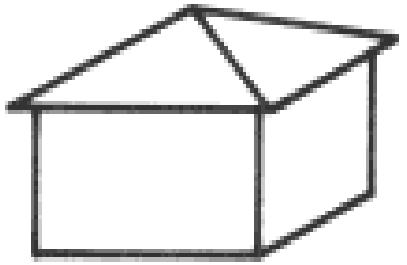
Vertical Construction

GABLE ROOF. This roof has two roof slopes that meet at the center (ridge), forming a gable. It is the most common roof because it is simple, economical, and may be used on any type of structure.



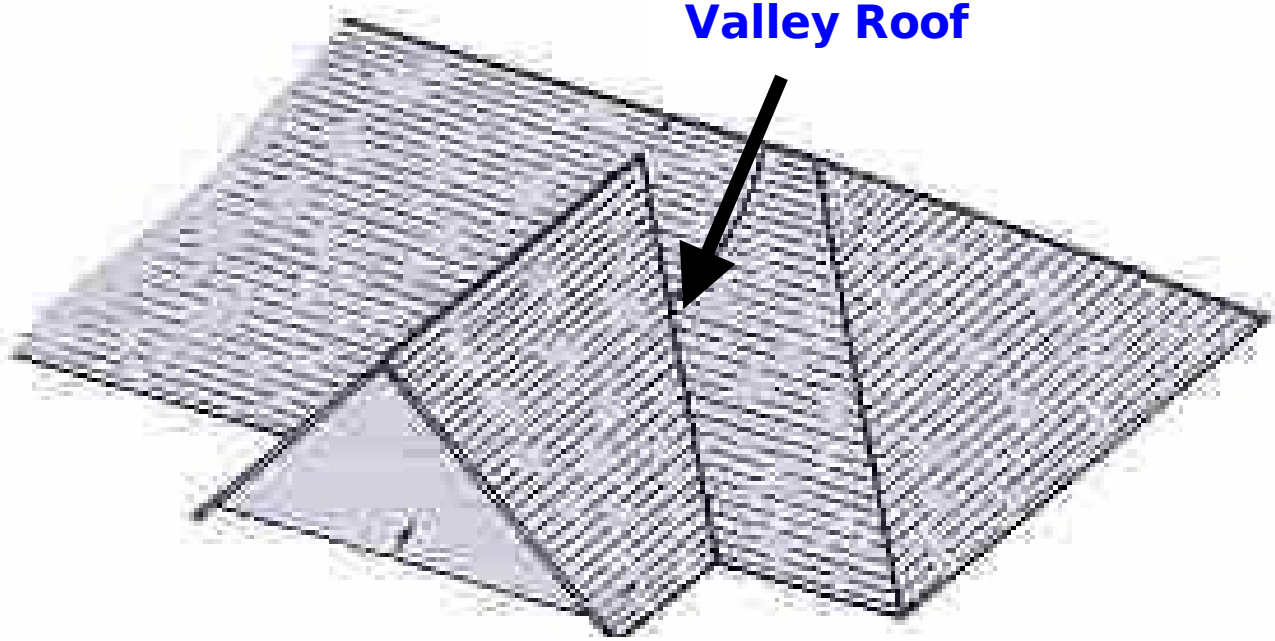
Vertical Construction

HIP ROOF. This roof has four sides or slopes running upward toward the center of the building to create a ridge (or peak). Rafters at the corners run diagonally from the bottom edge to meet at the center (ridge). Other rafters are then framed into these.

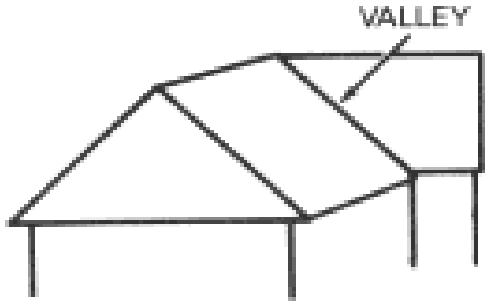


Vertical Construction

Gable &
Valley Roof



VALLEY ROOF. This roof is formed of two intersecting hip or gable roofs. The two roofs meet at a valley. Each roof slants in a different direction. This roof is seldom used, since it is complicated and requires much time and labor.



Vertical Construction

Vertical Construction

Ventilation

Ventilation “rules of thumb”

- 1sq. ft. of vent / 150sq. ft. of floor space without soffit vents
- 1sq. ft. of vent / 300sq. ft. of floor space with soffit vents
- Ventilation should be equally divided between high and low areas
- Vents should be evenly spaced to ensure all areas are vented

Vertical Construction

Ventilation

Vertical Construction

Ventilation

Vertical Construction

Ventilation

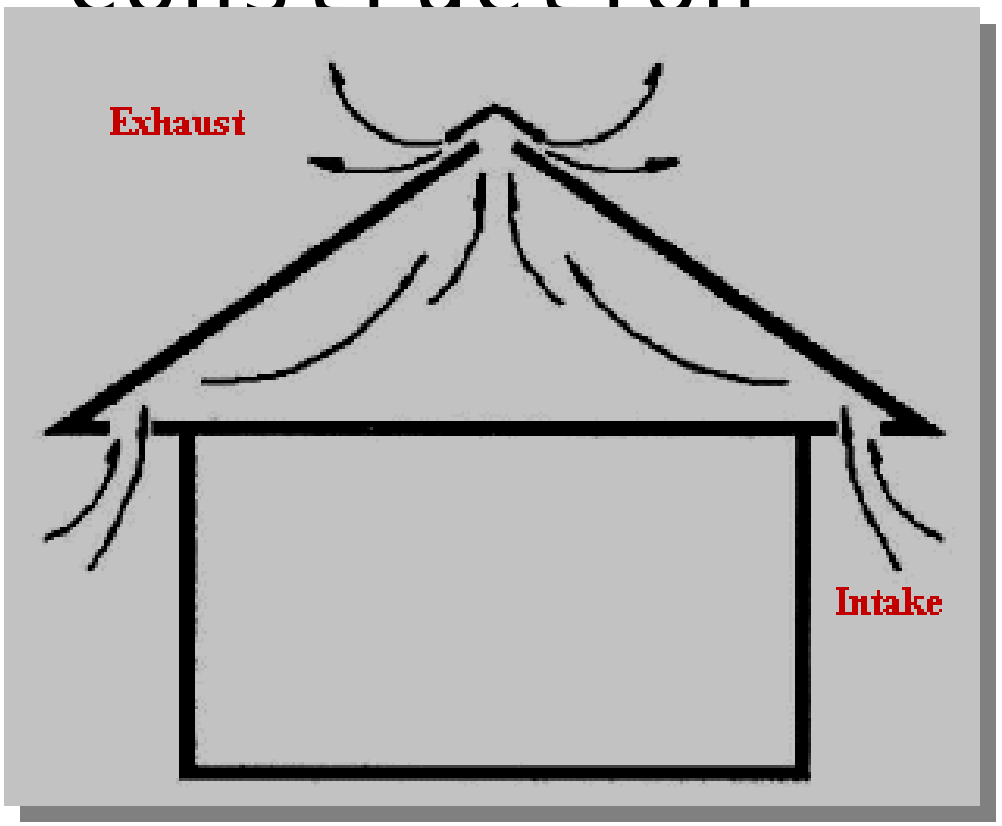
Eliminates moisture, reduces heat build-up and saves energy.

Types of Vents:

- Ridge vents. Are the most effective when used with soffit vents
- Rectangular vents are the easiest to install
- Soffit vents act as fresh air intake source
- Gable vents rely on wind direction and velocity to function

Vertical Construction

Ventilation



Effects of Poor Ventilation:

- Ice dams
- Structural damage
- Increased energy consumption

Vertical Construction

Vertical Construction

Roof Components: Trusses

Truss construction. Reinforced rafters for large spans

The ***upper chord*** and the ***lower chord*** ties the rafter and distributes the weight.

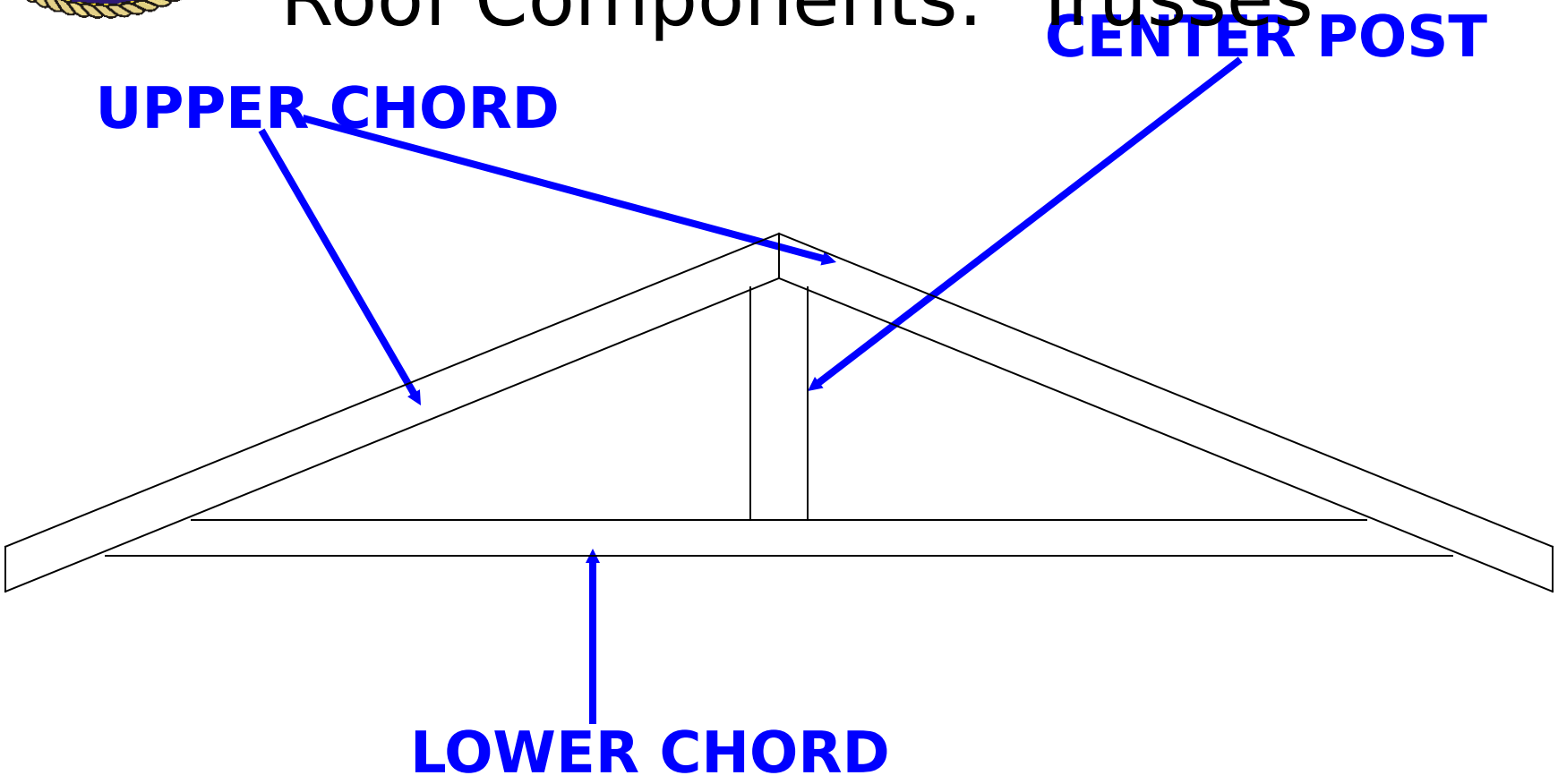
Lower chords becomes ceiling joist.

Diagonal Brace / Center post

Ties the upper and lower chord together and helps distribute the weight.

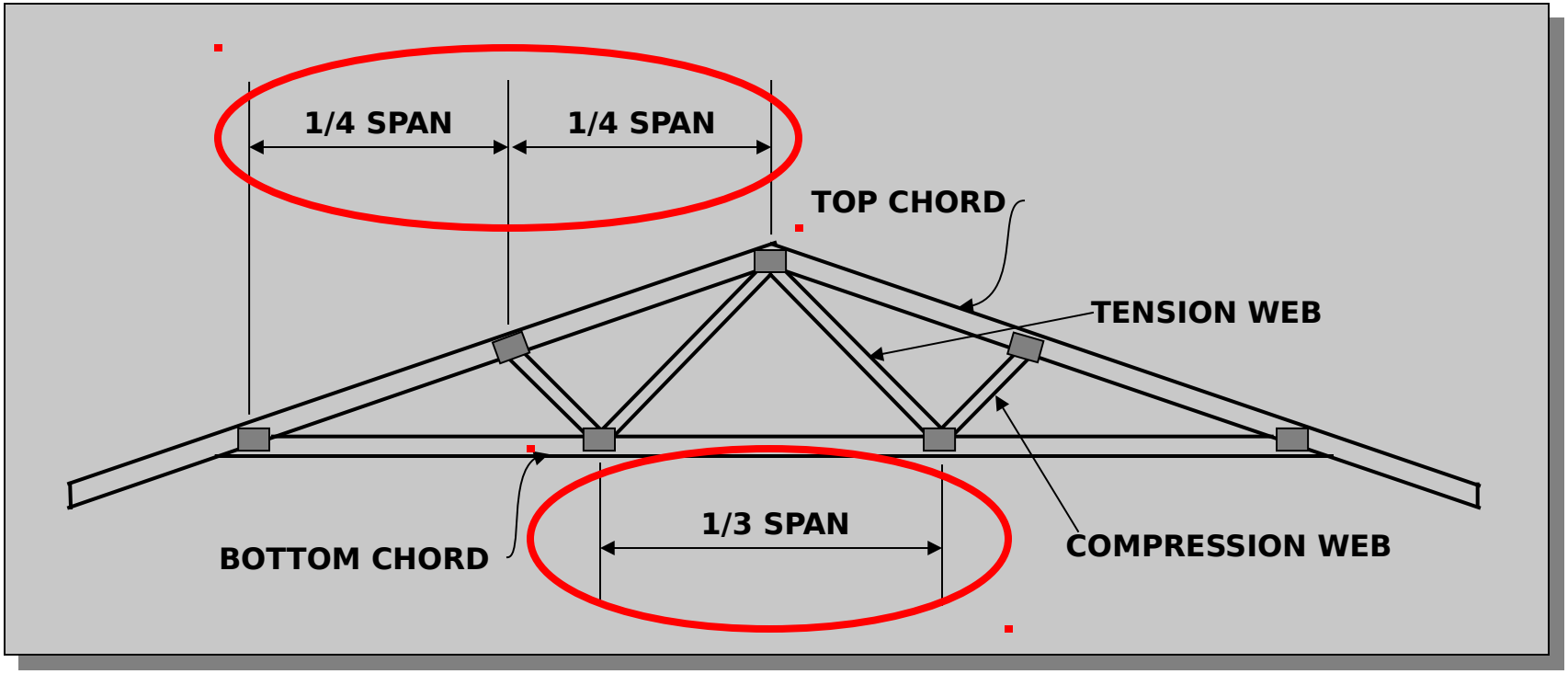
Vertical Construction

Roof Components: Trusses



Vertical Construction

Roof Components: Trusses



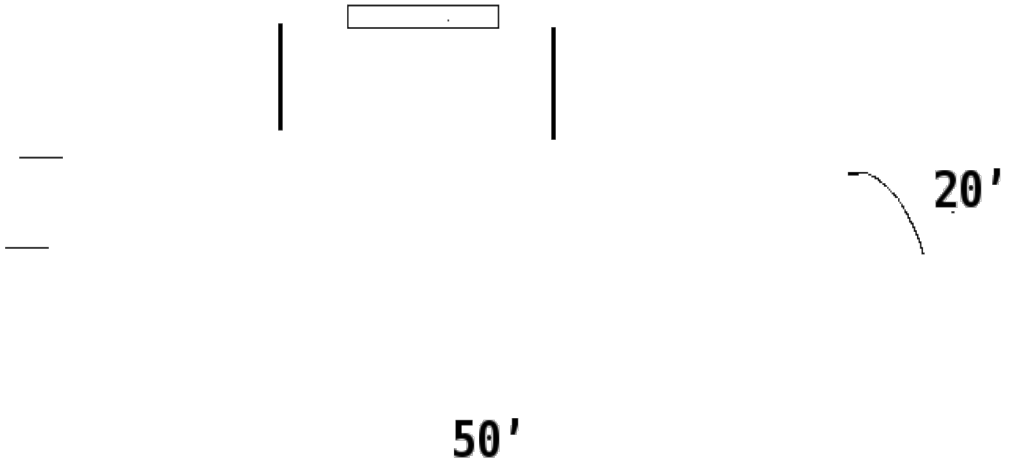
Vertical Construction

Roof Components: Trusses

Vertical Construction

Roof Components: Trusses

- Situation: You are given a building with the following dimensions of 20 feet wide and 50 feet long. The following sketch and information is provided.



Vertical Construction

Roof Components: Trusses

Determine the number of Trusses

Step1: Length of bldg ÷ Center-to-Center spacing of trusses:

Ex: 24” Spacing of trusses

50’ ÷ 2 = 25

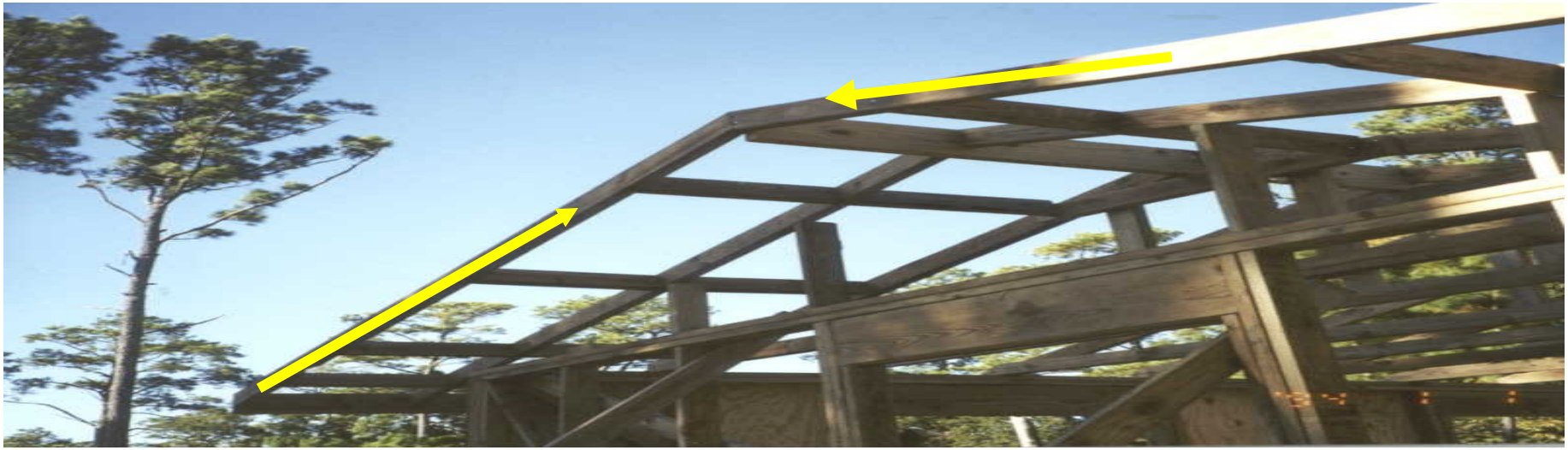
\+ 1 starter

26

\+ 2 False rafters (one on each end)

28

Vertical Construction



False Rafter extends beyond the end walls

Vertical Construction

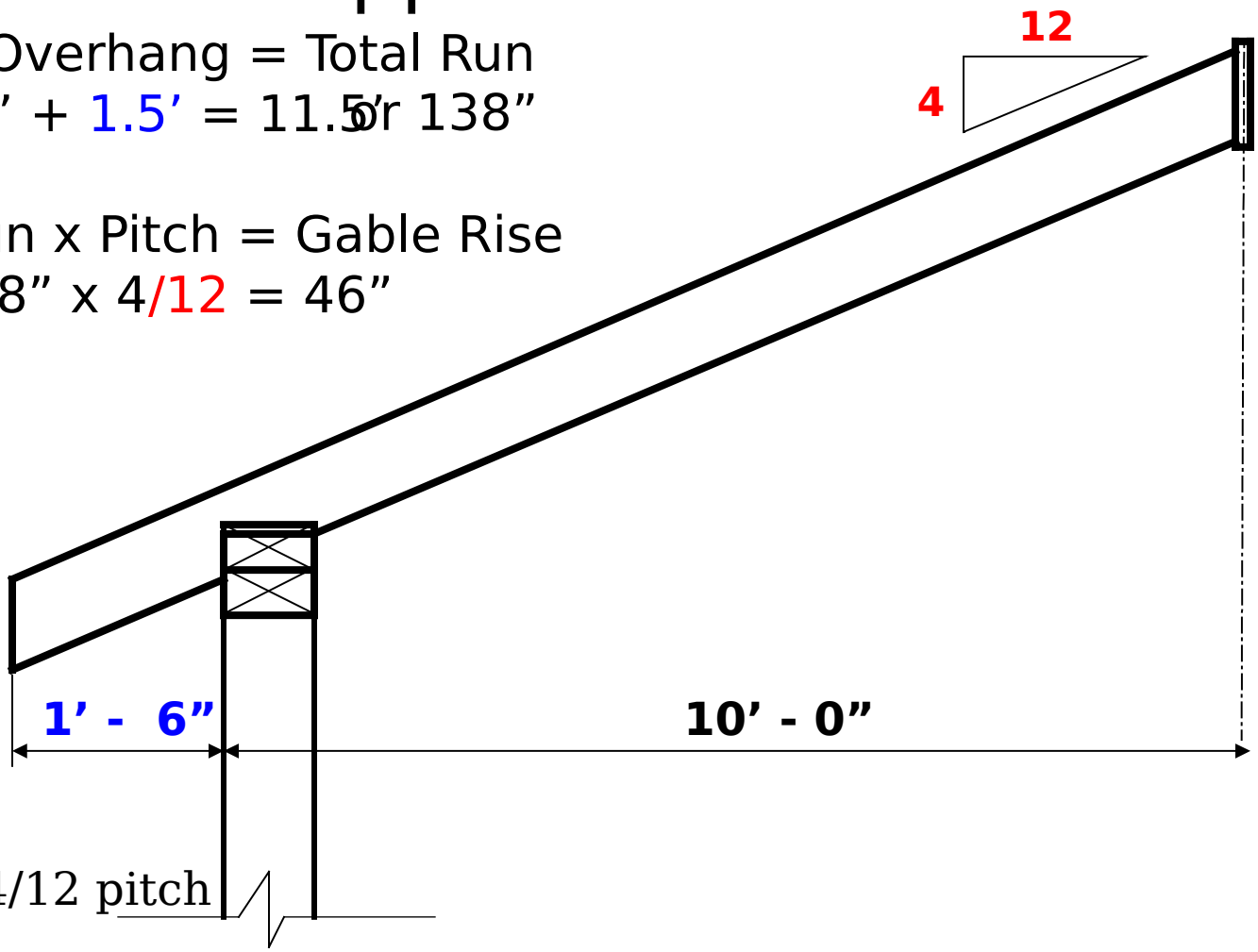
Estimate Upper Chord

Step 1: Run + Overhang = Total Run

10’ + 1.5’ = 11.5’ or 138”

Step 2: Total Run x Pitch = Gable Rise

138” x 4/12 = 46”



Given:

A span of 20 feet, 4/12 pitch

Overhang of 18”

2 x 4 material

TRUSSES

Vertical Construction

Estimate Upper Chord

STEP 2: With the span and the rise measurement, the upper chord length will be determined by using the Pythagorean Theorem (A2 + B2 = C2)

A = ½ Bldg width
B = center post
C = upper cord

Vertical Construction

Estimate Upper Chord

Step 3:

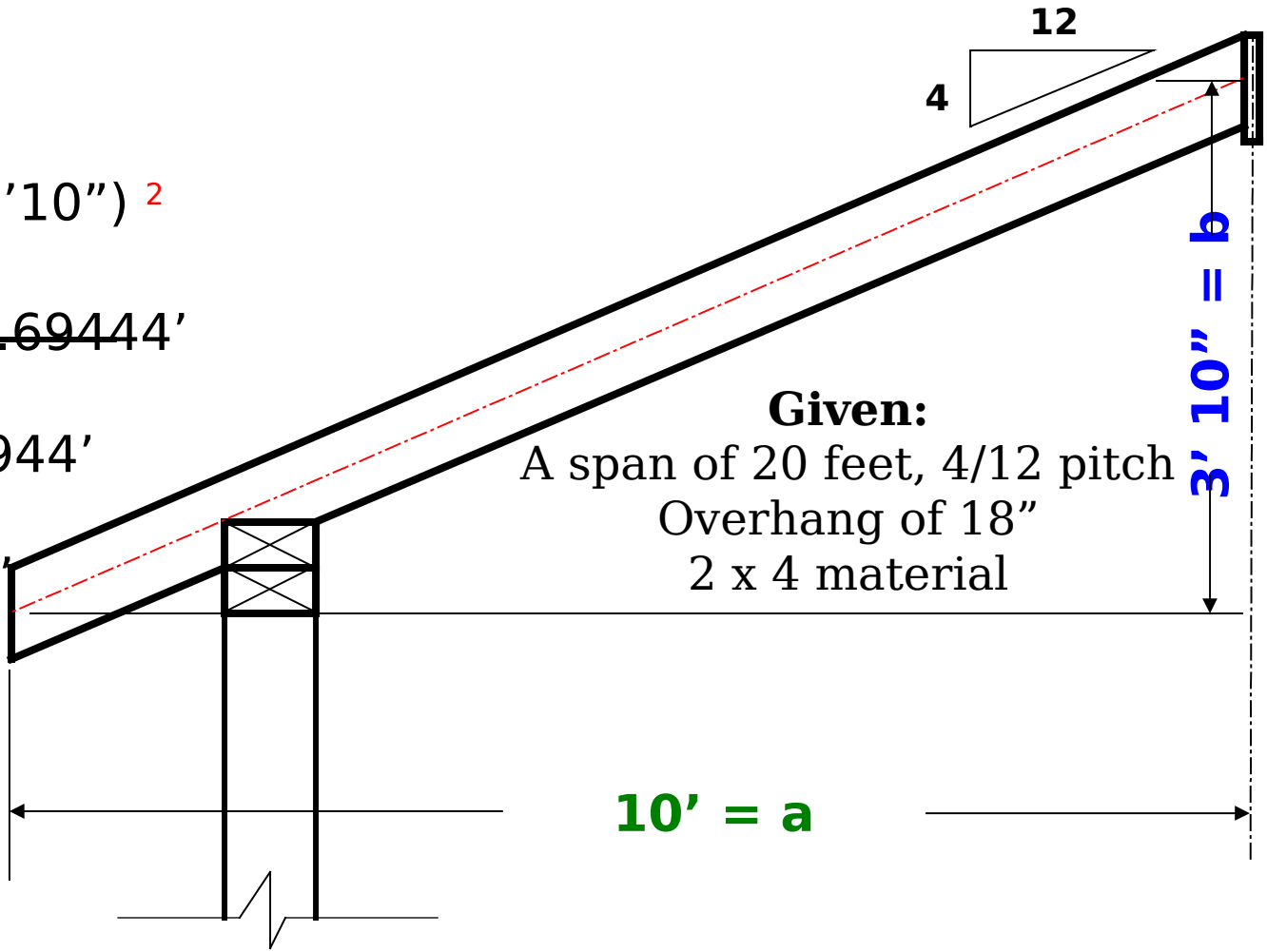
$c^2 = a^2 + b^2$

$c^2 = (10')^2 + (3'10")^2$

$c^2 = 100' + 14.69444'$

$c = \sqrt{\quad}$ $114.6944'$

$c = 10.70955'$



Vertical Construction

Estimate Upper Chord

Step 4

10.64874’

- 10.00

.64874

X 12.00

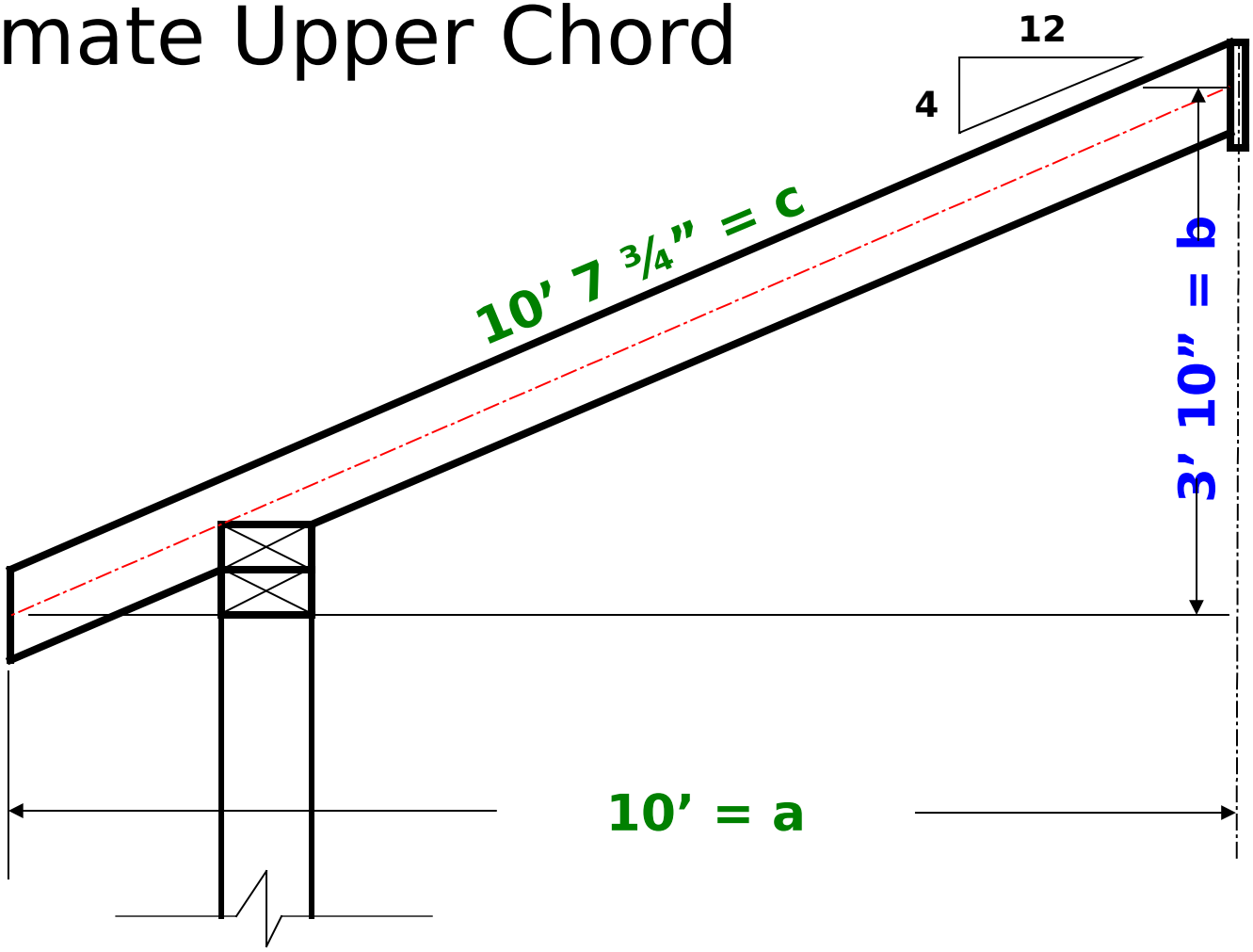
7.78488

- 7.00

.78488

X 16.00

12.55808

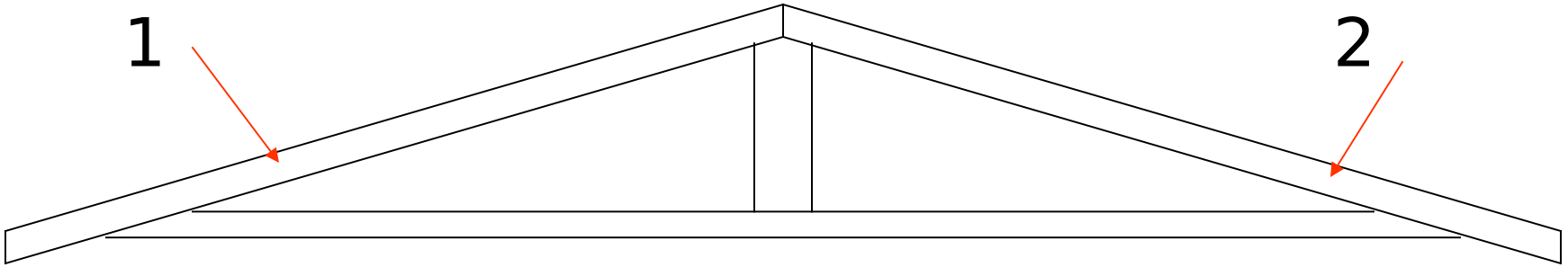


10’ 7 12/16 OR 10’ 7 ¾”

Vertical Construction

Estimate Upper Chord

The truss will consist of 2 upper chords



28 trusses x 2 upper chords = 56

56 pcs at 10’ 7 ¾”

Step 2: Determine best EOL Rule

10’ 7 ¾” Upper cord EOL is 2x4x12

Step 3: ADD 10% for Waste and Convert to BF

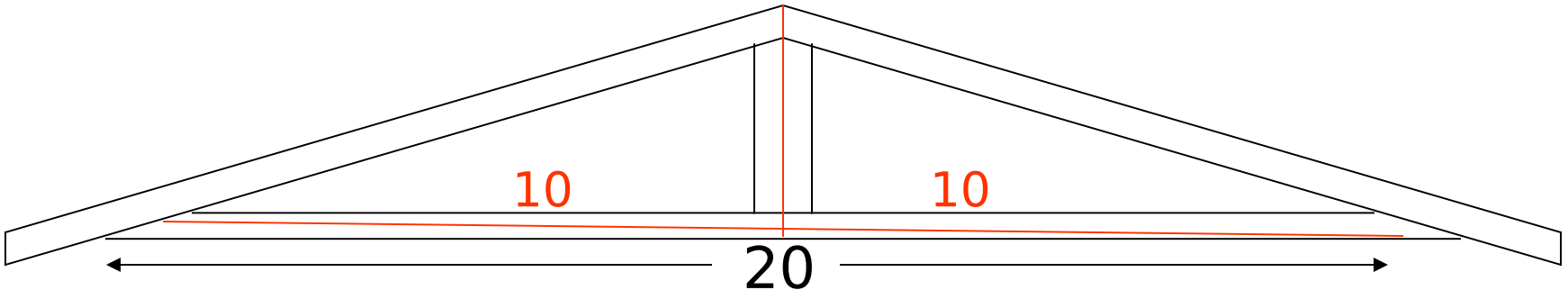
62 pcs 496 BF

Vertical Construction

Estimate Lower Chord

Depending on the width of the Bldg the truss could have 2 lower chords

Best EOL is determined by building width



USING OUR 28 TRUSSES WE WILL DETERMINE WHAT WE NEED

28 - 2 for false rafters = 26pc

26pcs x 2 sides = 52 pcs at 10’

Vertical Construction

Estimate Lower Chord

Step 2: ADD 10% for Waste and Convert to BF

52 x 1.1 = 57.2 OR 58 PCS

(58 x 2” x 4” x 10’) ÷ 12 = 386.66 BF

Vertical Construction

Estimate Center Post

Using our 28 trusses we will determine the center posts required

28 - 2 for false rafters = 26 pcs

Subtract the width of the upper & lower chord from the rise height (2x4 = 3 ½ & 2x6 = 5 ½)

46 inches riser HT – 7” for materials = 39” Center Post

Vertical Construction

Estimate Center Post

STEP 3: Determine the best EOL by dividing each EOL by the size of center post.

192” / 39 = 4.92

168” / 39 = 4.30

144” / 39 = 3.69

120” / 39 = 3.07

96” / 39 = 2.46

Use Rule # 3: Choose the smallest number after the decimal and round down.

10’ (120”) EOL gave the amount of waste:

Vertical Construction

Estimate Center Post

Step 4: Divide the number of pcs per EOL by number of pcs needed and round UP

3 pcs out of one 10’ board
26 center post needed at 39” ÷ 3 pcs from EOL = 8.6 or 9 pcs of 10’
9 x 1.1 = 9.9 OR 10 PCS

Step 5: ADD 10 % WASTE & CONVERT BF: 10 x 2 x 4 x 10) ÷ 12 = 66.66 BF

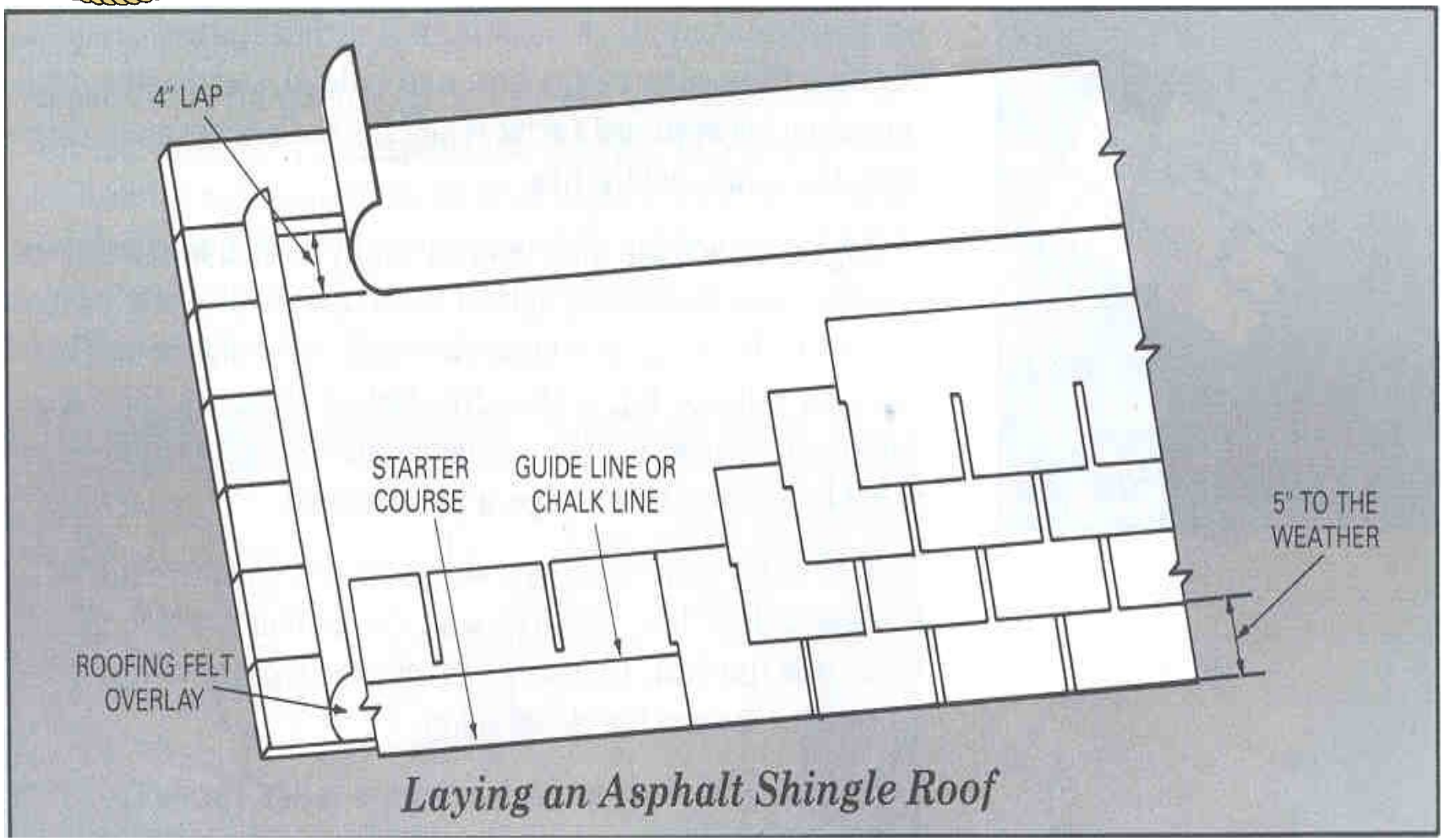
Vertical Construction

Vertical Construction

Roof Coverings

- **Sheathing:** 1/2, 5/8, or 3/4” plywood adequate
- **Flashing:** Is used in places especially vulnerable to leakage
- **Felt:** Felt paper is laid for extra protection. A roll usually covers 400 or 500 sqft.
- **Shingles:** 3 or 4 bundles will cover a square (100 square feet).

Vertical Construction



Laying an Asphalt Shingle Roof

Vertical Construction

Estimate Roof Sheathing

Step 1: Determine amount of roof area to be covered

Upper chord length rounded up to the nearest whole foot x length of building plus any overhang = sq foot of one side of roof

11’ 7 13/16” upper chord and 2’ overhang

12’ x (50’ + 4’) = sqft per side <u>648 sqft</u>

Vertical Construction

Estimate Roof Sheathing

Step 2: Multiply sqft per side x 2 for entire roof area

648 x 2 = 1296 sqft (entire roof)

Step 3:Total Sqft ÷ 32 (sqft of plywood) = number of sheets (don't round up)

1296 ÷ 32 = 40.5 sheets

Step 4: Add 20% waste and round up

40.5 x 1.2 = 48.6 rd up 49 sheets

Vertical Construction

Estimate Roof Sheathing

Roofing felt comes in 400 or 500 sqft per roll

-Total Sqft of Roof ÷ sqft of roll of roofing felt

1296 ÷ 400 = 3.24 Do not round up

-ADD Waste 10% :

3.24 x 1.1 = 3.56 OR 4 ROLLS

Vertical Construction

Estimate Roof Shingles

Material come in bundles which require 3 or 4 bundles to make a square (one square covers 100 sqft

-Total Sqft of Roof ÷ 100 = number of 100 ft squares

1296 ÷ 100 = 12.96 DO NOT Rd up

-ADD Waste 10%:

12.96 x 1.1 = 14.2 Rd up 15squares

Vertical Construction

Estimate Roof Shingles

Multiply number of squares x bundles per sq
(either 3 or 4)=bundles of shingles 15 squar
bundles/square = 45 bundles of shingles

Vertical Construction

Estimate Roof Shingles

1 lb of roofing nails = 100 SQFT

- THE FORMULA IS:

  Square foot of the roof ÷ 100 (add waste) x 2 (for felt and shingles)

- Square foot of the roof = *1296* ft^2

  1296 ÷ 100 = 12.96 LBS

- Add 10 % : 12.96 x 1.1 = 14.256 LBS

  14.256 X 2 (for felt and shingles) = 28.512 or 29 lbs of roof nails

Vertical Construction

Vertical Construction

Estimate Nails

- For 1” material use 2D - 9D NAILS
- Consider all plywood to be 1” thick
- Use the formula: = (d) x BF ÷ 400 = lbs of nails
- Add waste: lbs of nails x 1.1
- Go the the material take off sheet, total all sheets of plywood to determine bf

MATERIAL TAKEOFF SHEET

ITEM	# OF PCS.	SIZE LUMBER	TOTAL BDFT.	REMARK
SILL	16	2” x 8” x 10’	205.33	
GIRDER	22	2” x 12” x 10’	440	
JOIST	95	2” x 8” x 12’	1,520	8 trimmer joist
HEADER	11	2” x 8” x 10’	168	
BRIDGING	10	2” x 8” x 16’	213.33	16’ = 13 pcs of 14.5” long solid bridging
STRINGER	5	2” x 10” x 12’	100	2 stringers/stairs
TREAD BOARD	19	2” x 4” 12’	152	12’ = 3 pcs of 3’ long treads
PLATES	60	2” x 4” x 14’	333.33	
STUDS	184	2” x 4” x 8’	981.33	LONG METHOD
UPPER CHORD	62	2” x 4” x 12’	496	Lgt: 11’ 7-13/16”
LOWER CHORD	58	2” x 4” x 10’	386.66	Lgt: 10’
CENTER POST	7	2” x 4” x 16’	74.66	16’=5 pcs of 37” long ctr.post
SUBFLOOR	38 shts.	3/4” x 4’ x 8’	Plywood	
EXTERIOR WALL	42 shts.	3/4” x 4’ x 8’	Plywood	
GABLE	6 shts.	3/4” x 4’ x 8’	Plywood	
ROOF	49 shts.	1/2” x 4’ x 8’	Plywood	Roof = 1296 sqft
INTERIOR WALL	104 shts.	1/2” x 4’ x 8’	Sheet rock	
SHT. ROCK NAIL	31 Lbs.			
FELT PAPER	5 rolls	400		
SHINGLES	45 bundles	4 bun		
ROOFING NAILS	29 Lbs.			Roof = 1296 sqft
8d NAILS				
16d NAILS	.			

= 135 shts.

Vertical Construction

Estimate 8d Nails

- 135 x 1” x 4’ x 8’ = 4320 BF or take 135 X 32
- Determine the amount of nails required
  (8 d x 4320) = 34560 ÷ 400 = 86.4 LBS
- Add 10% waste = 86.4 x 1.1 = 95.04 OR 96 lbs of 8d

Vertical Construction

Estimate 16d Nails

For 2’ material: 10d – 16d nails use the formula:

(NAIL SIZE d x TBF) ÷ 600=Lbs of nails

*Go to the material take off sheet and total all 2” x x” material board foot

MATERIAL TAKEOFF SHEET

ITEM	# OF PCS.	SIZE LUMBER	TOTAL BDFT.	REMARK
SILL	16	2” x 8” x 10’	205.33	
GIRDER	22	2” x 12” x 10’	440	
JOIST	95	2” x 8” x 12’	1,520	8 trimmer joist
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INTERIOR WALL	104 shts.	1/2” x 4’ x 8’	Sheet rock	
SHT. ROCK NAIL	31 Lbs.			
FELT PAPER	5 rolls	400 sqft/roll		
SHINGLES	45 bundles	4 bundles/square		
ROOFING NAILS	29 Lbs.			Roof = 1296 sqft
8d NAILS	96 Lbs.			
16d NAILS	.			

= 5049.3 BF

Vertical Construction

Estimate 16d Nails

16d x 5123.97 Total BF= 81983.52 ÷ 600 = 136.6392

Add 10% Waste:

136.6392 x 1.1 = 150.3031 or 151 lbs

Vertical Construction

Vertical Construction

Estimate Man-hours

Various factors contribute to the estimation of time to complete a project:

- Weather
- Number of Marines on-hand
  - Are they trained to the task(s)
- Equipment

Vertical Construction

Estimate Man-hours

EX: 50’ X 20’ bldg

Using the chart from FM 5-426, find the man-hours required for 400 bf of wall frame plates

Step 1: Turn board feet into thousand board feet measurement (Mbfm)

400 BF plates ÷ 1000 BF = .4 Mbfm

Step 2: Find wall frame plates on the chart

Vertical Construction
Estimate Man-hours

Work element description	Unit	Man-hours/unit
Beams (3-2" x 8")	Mfbm[2]	40
Floors joists, sills	Mfbm	32
Bridging	100 pairs	5
Wall frames, plates	Mfbm	56
Furring, include plugging	1,000 linear feet	32
Blocking	Mfbm	32
Grounds for plaster	1,000 linear feet	48
Door bucks	Each	3
Ceiling joists	Mfbm	32
Rafters	Mfbm	48

		Man-hours Assembly	Man-hours placement
Trusses	**Each**		
Span feet			
20		**2.5**	**4**
30		**5**	**8**
40		**12**	**8**
50		**20**	**6[3]**
60		**24**	**6[3]**
80		**32**	**6[3]**

[1]Typical Crew: 1 leader, 8 men. Minimal crew ; 1 leader, 2 men.
[2]Thousand board foot measure.
[3]Assumes use of organization crane, 1 operator, 1 oiler, 2 or 3 men guylines

Vertical Construction

Estimate Man-hours

Step 3: Multiply Mbfm x number of man hours stated in chart

.4 Mbfm (plates) x 56 = 22.4 man-hours

Vertical Construction

Summary